Bear Creek Basin Plan Webinar – December 12, 2016

Jeff Burkey

Tim Clark

Eric Ferguson

Steve Brady

Jen Vanderhoof

King County

City of Redmond
WASHINGTON

Snohomish County

The City of Woodinville

WSDOT

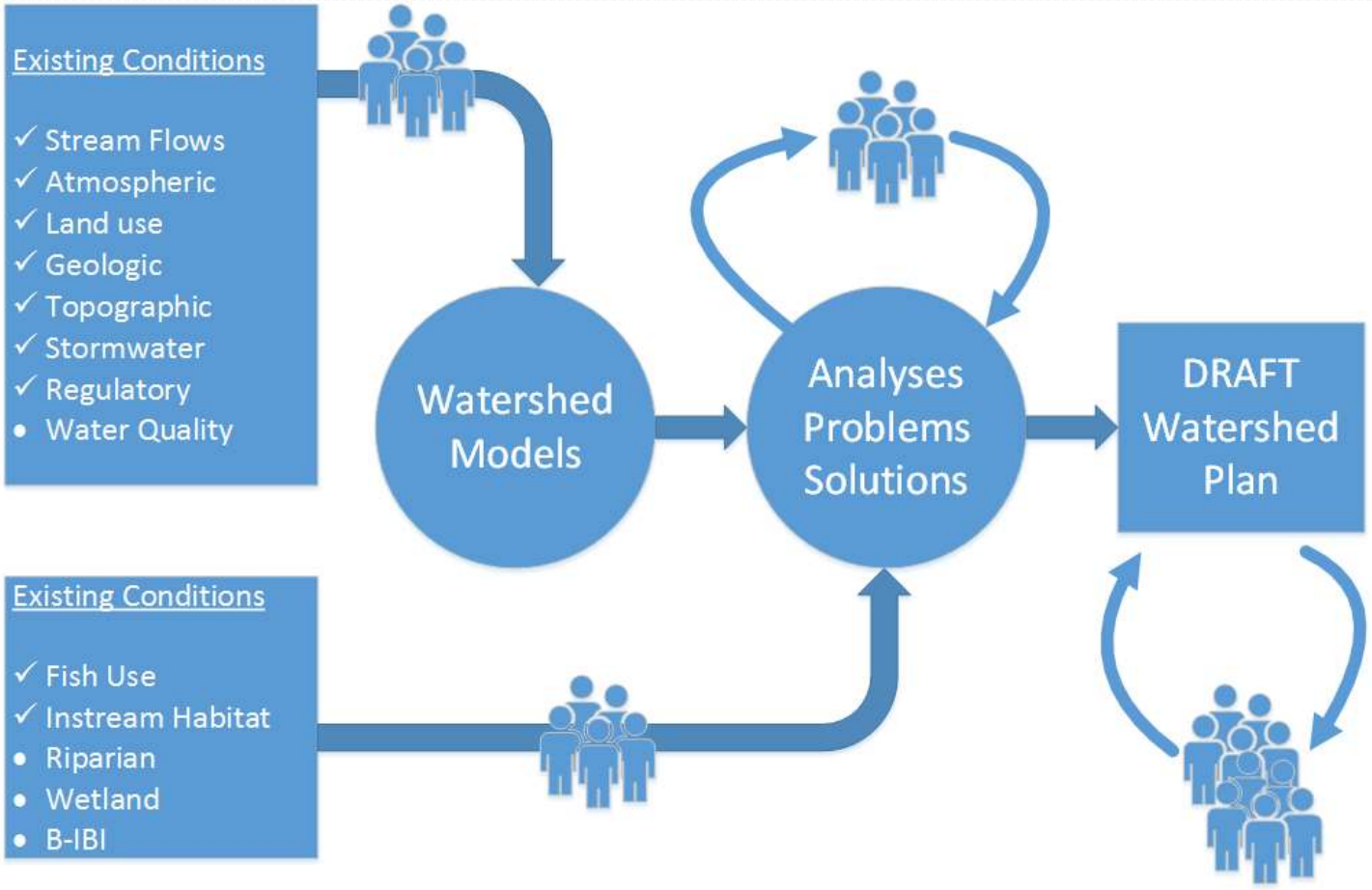
Webinar Outline

- Welcome & Introductions
- Overall Project Update – Jeff Burkey
- Project Reports
  - Water Quality – Tim Clark
  - BIBI – Steven Brady
  - Wetland Vegetation – Jen Vanderhoof
  - Riparian Vegetation – Jen Vanderhoof
- Summary and Next steps - Jeff Burkey

Overall Project Update

Milestones

- ✓ Form Partnerships
- ✓ Storm Monitoring
- ✓ Mapping
- Model Development (December 2016)
- Existing Conditions Assessment (December 2016)
- Stormwater Management Strategies and Draft Implementation Plan (June 2017)
- Final Watershed Plan (April 2018)



Water Quality

Tim Clark

Eric Ferguson

Bear Creek Technical Webinar

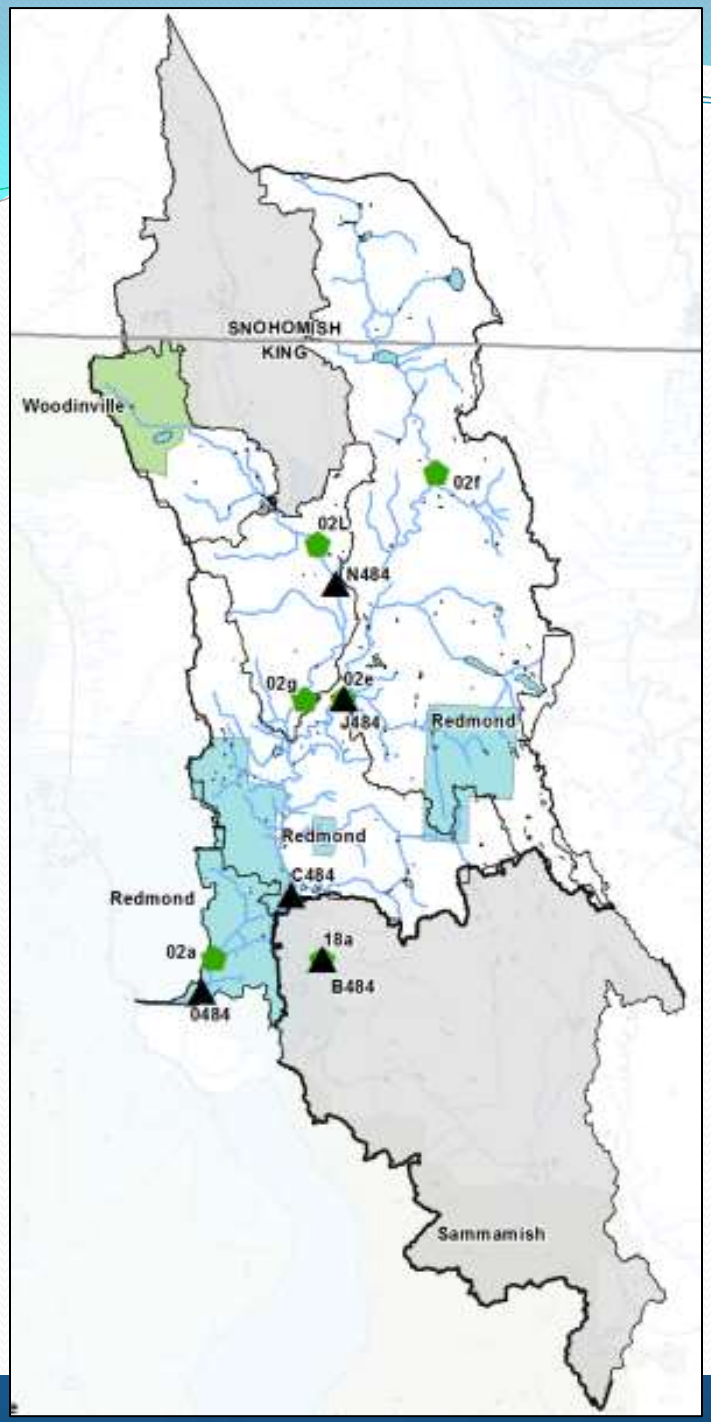
December 12, 2016

Department of Natural Resources and Parks
Water and Land Resources Division

King County

Long-term Monitoring in Bear Creek

- King County has monitored the Bear Creek watershed as part of its Stream and River Monitoring Program since the 1970s.
  - Nutrients
  - Fecal coliform bacteria
  - Temperature, dissolved oxygen, pH, conductance
- Metals and organic compounds sampled as part of specific projects
- Evans Creek and lower Bear Creek sites included in historic trend analysis to detect changes across the watershed.

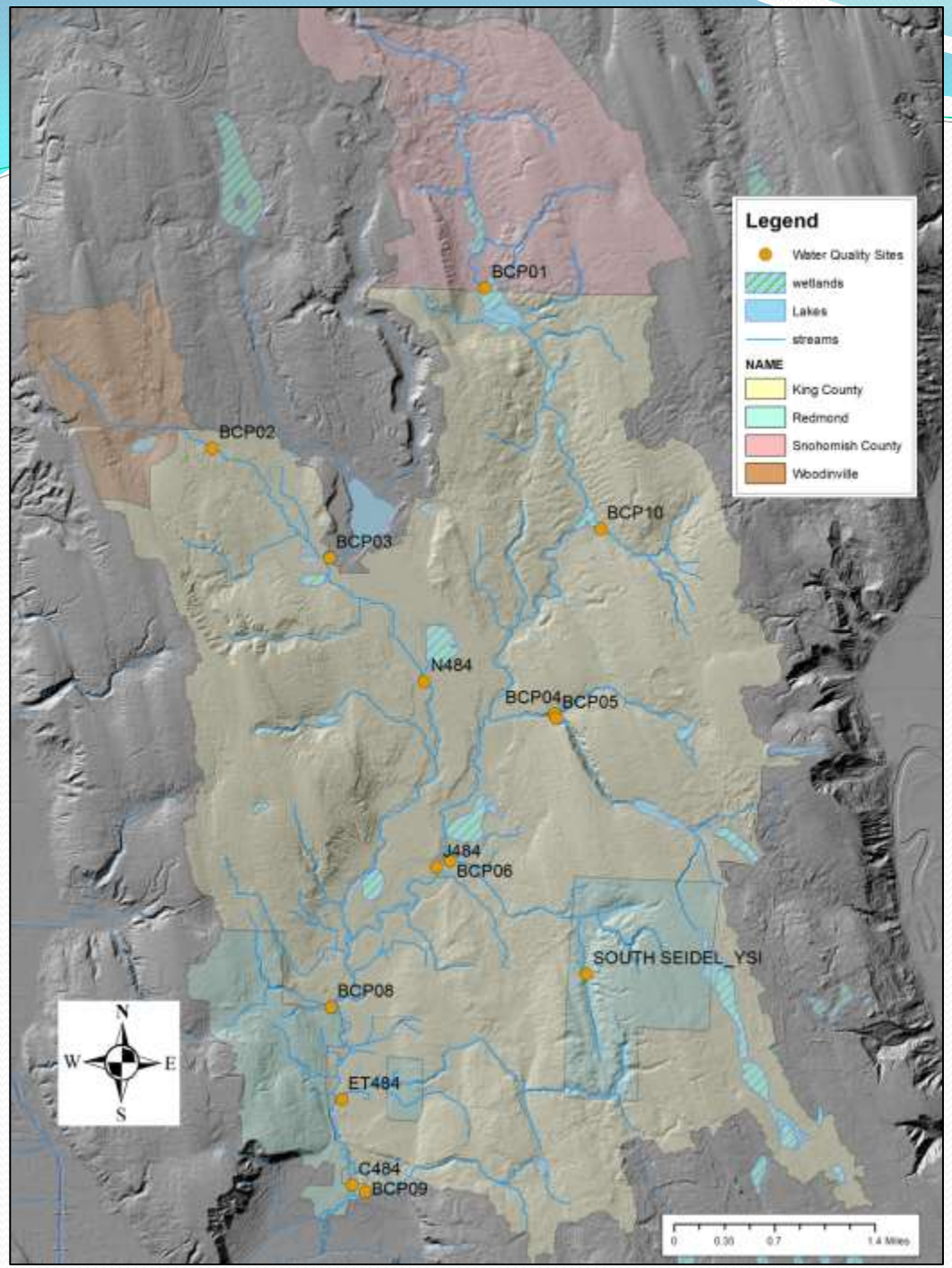


Bear Creek Watershed

- Bear/Evans/Cottage Lake Creeks are approximately 31,200 acres
- 5 sites used for long-term water quality
- 6 sites used for continuous temperature data

Legend

- Long-term water quality sites
- Continuous temperature sites
- Area outside Basin Plan study area
- Local jurisdictions



Current Conditions

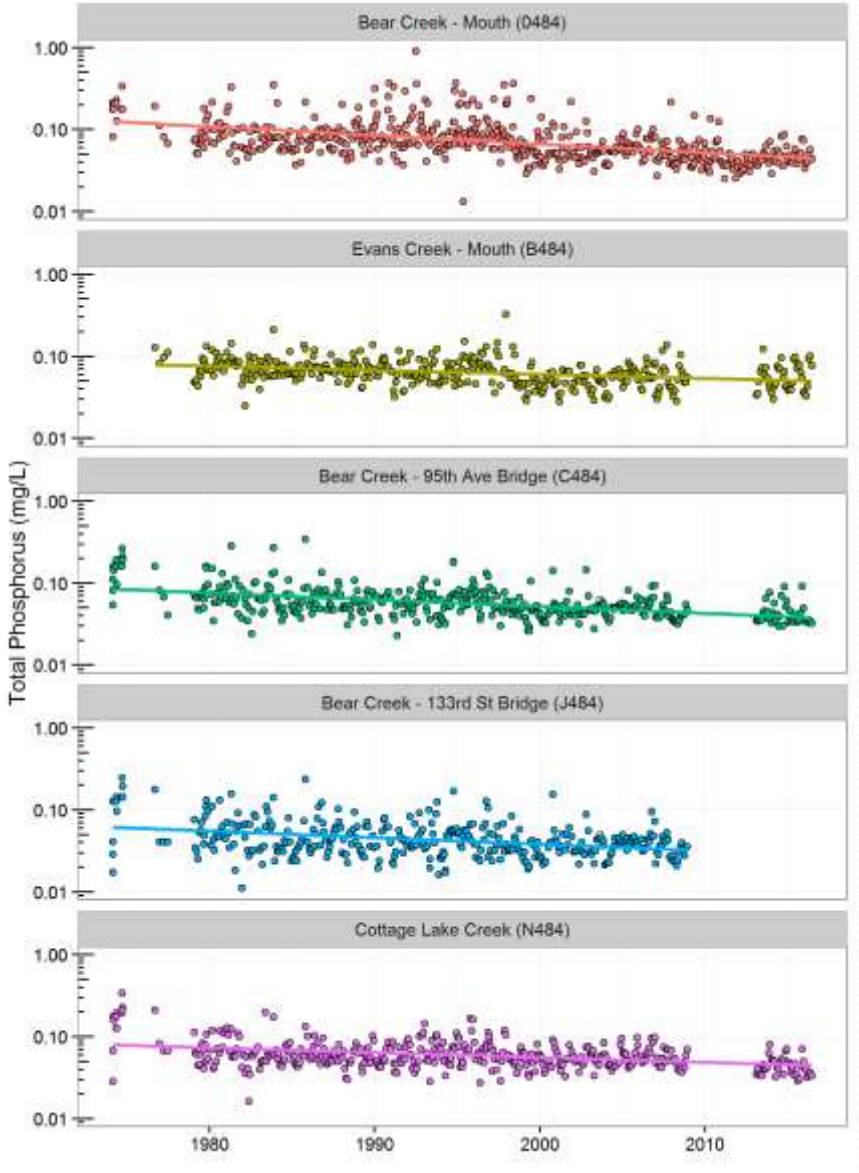
- 13 sites monitored for Water Quality
  - 6 Base Flow, 6 Storm Events
  - March 2015 – January 2016
- Parameters Analyzed include:
  - Dissolved Oxygen,
  - Temperature
  - Total Suspended Solids
  - Dissolved Zinc, Copper
  - Fecal Bacteria
  - Nitrogen

Trend Results

+ Bacteria is improving (90% decline at 0484 from 1975 – 2015)
- Temperature is increasing (0.3 to 0.6 °C per decade)
- Dissolved oxygen is decreasing (0.1 to 1 mg/L per decade)
  - Big decrease at Evans Creek
+ Nutrients are decreasing (20-70% decreases)

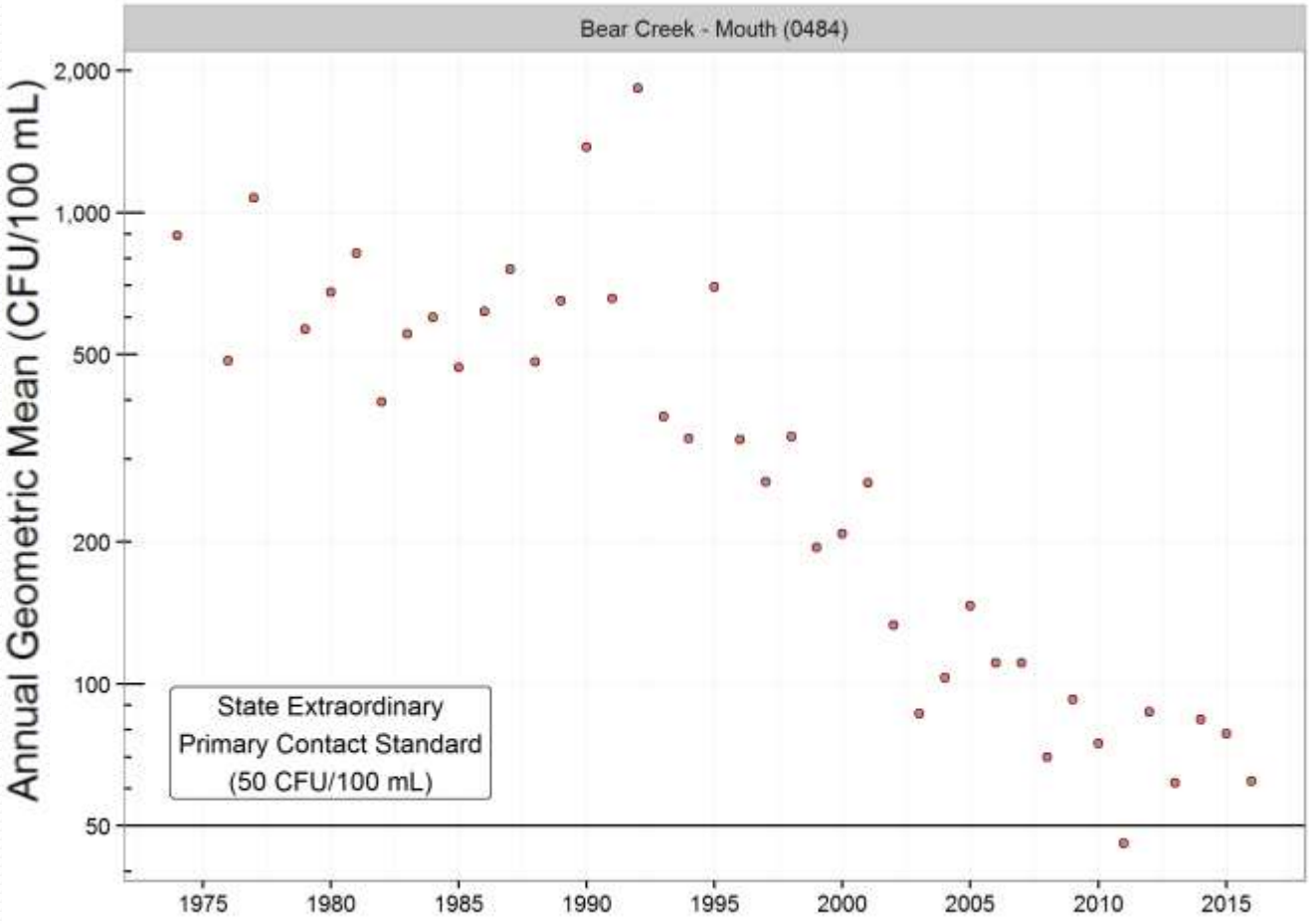
Parameter	Bear Creek @ Redmond (0484)	Bear Creek @ 95th Ave Bridge (C484)	Bear Creek @ 133rd Ave Bridge (J484)	Cottage Lake Creek @ Tolt Pipeline (N484)	Evans Creek @ Union Hill Rd (B484)
Fecal Coliform	↘	↘	↘	↘	↘
Temperature	↗	↗	↗	↗	↗
Dissolved Oxygen	–	↘	↘	↘	↘
pH	–	↗	–	–	↘
Conductance	↗	↗	↗	↗	↗
Total Suspended Solids	↘	↘	↘	↘	↘
Turbidity	–	↗	–	–	–
Total Phosphorus	↘	↘	↘	↘	↘
Ortho-phosphorus	↘	↘	↘	↘	↘
Total Nitrogen (1993 forward)	↘	↘	↘	–	–
Ammonia	↘	↘	–	–	↘
Nitrate + Nitrite	↘	–	↘	–	↘

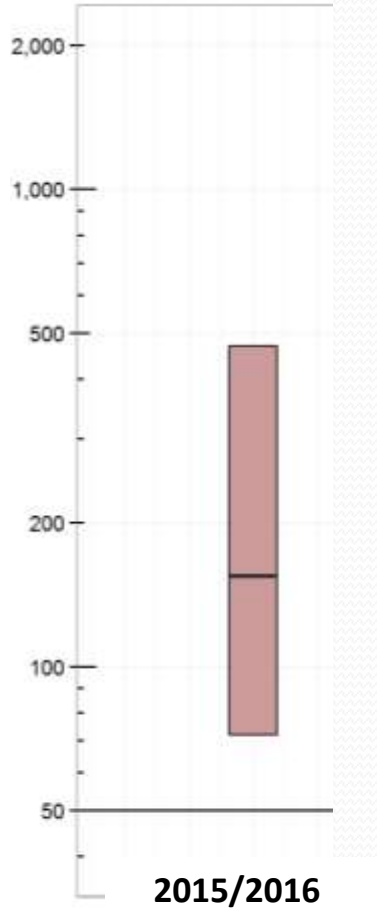
Nutrients are decreasing over time



- Phosphorus at all sites (30 to 60%)
- Nitrogen at some sites
  - 70% NO3 at Evans
  - 61% NH4 at Bear mouth

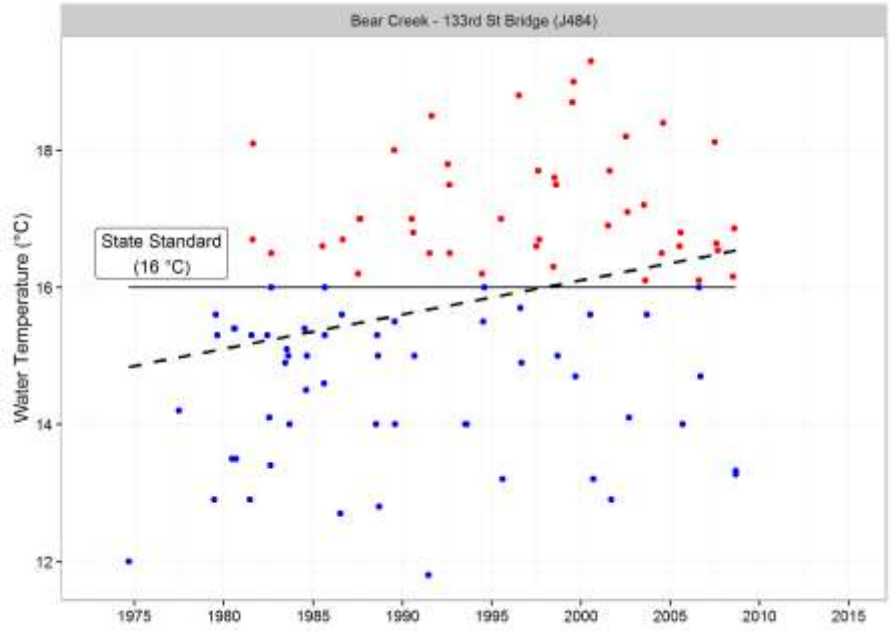
Fecal coliforms have decreased but still above standard



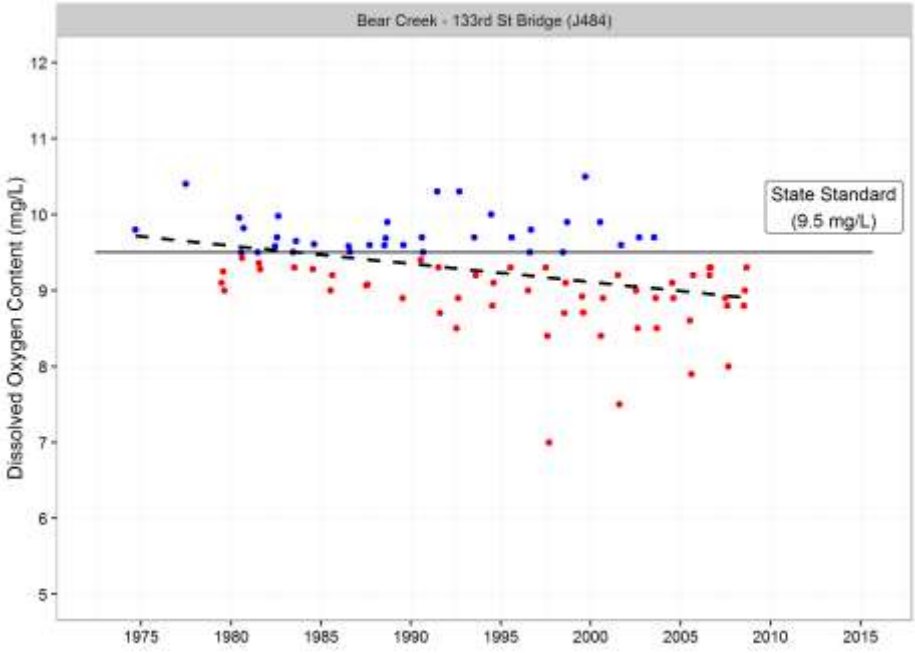


2015/2016 Bacteria Range Area-Wide

Temperature and DO getting worse



Increased frequency and magnitude of state standards violations for temperature

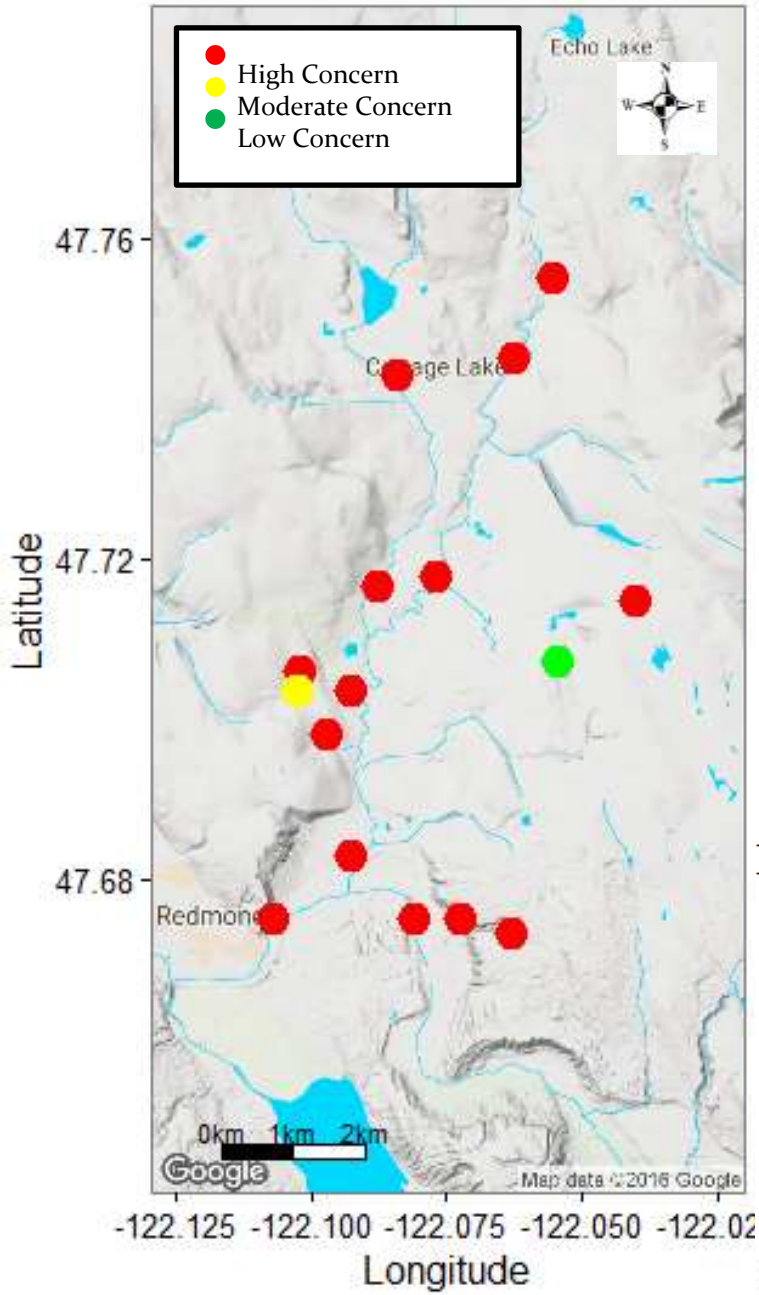


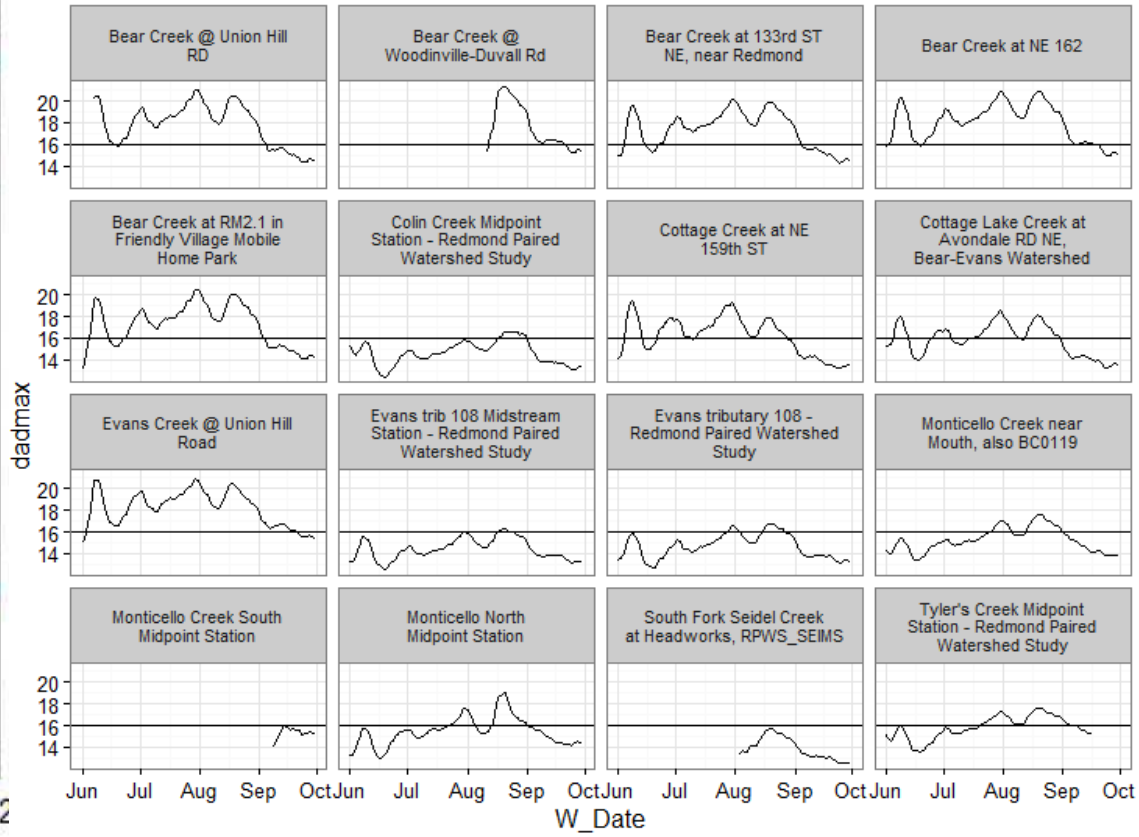
Increased frequency and magnitude of state standard violations for dissolved oxygen

Current Conditions

Temperature

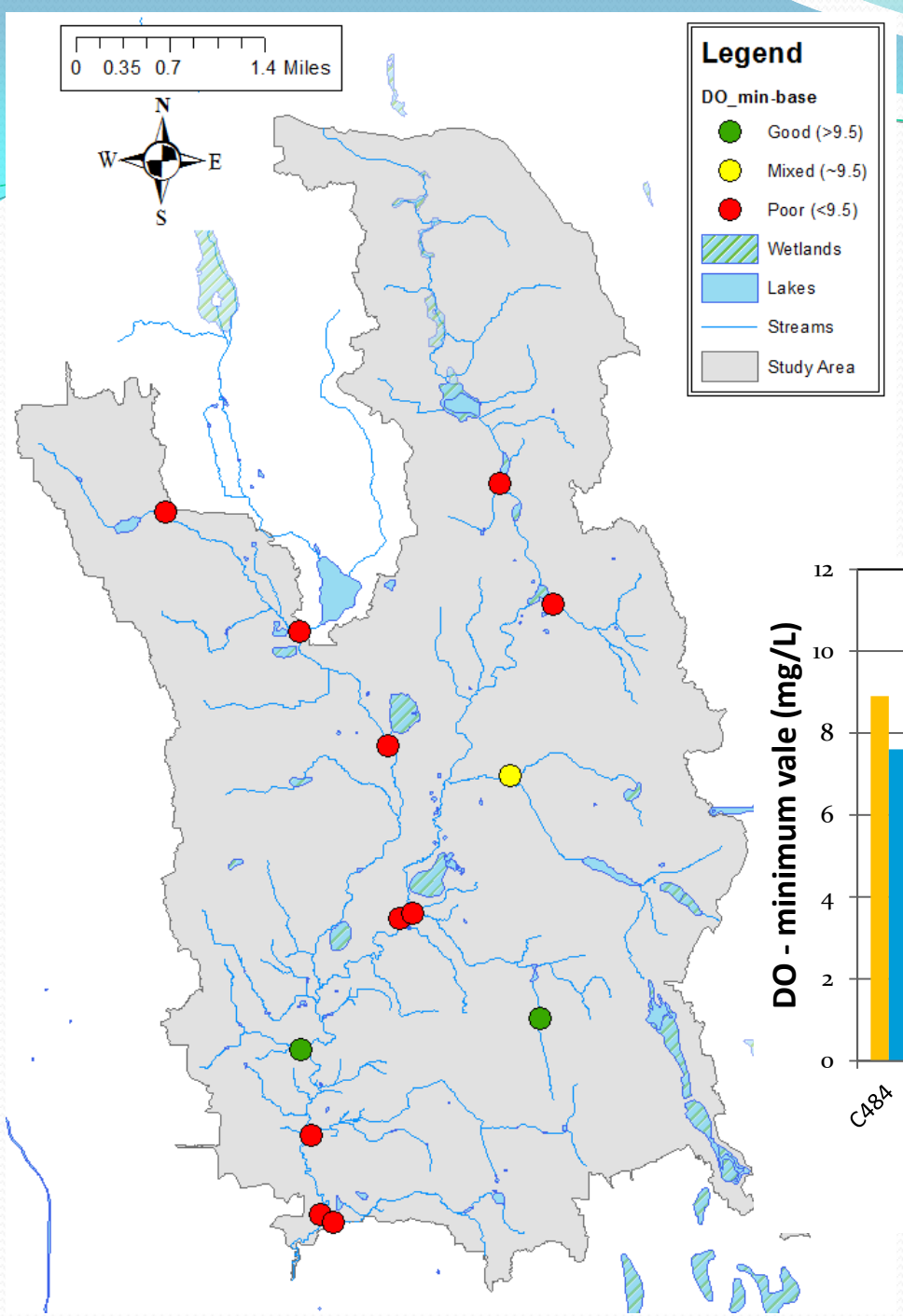
- Violated state standards throughout watershed in 2016.

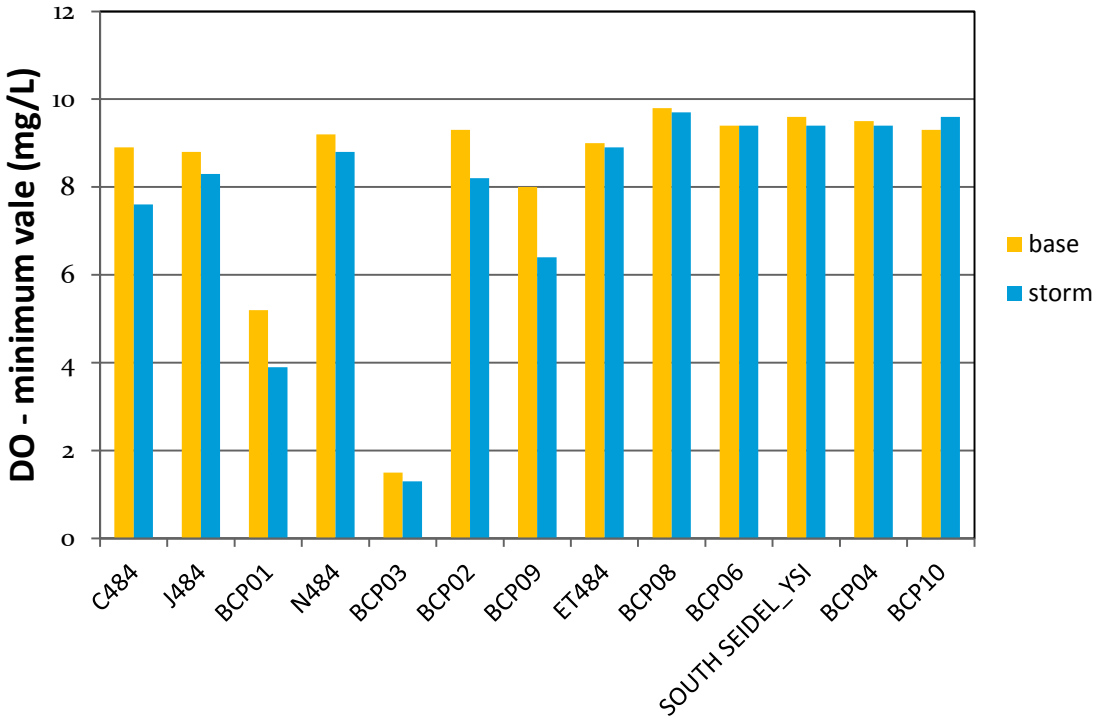




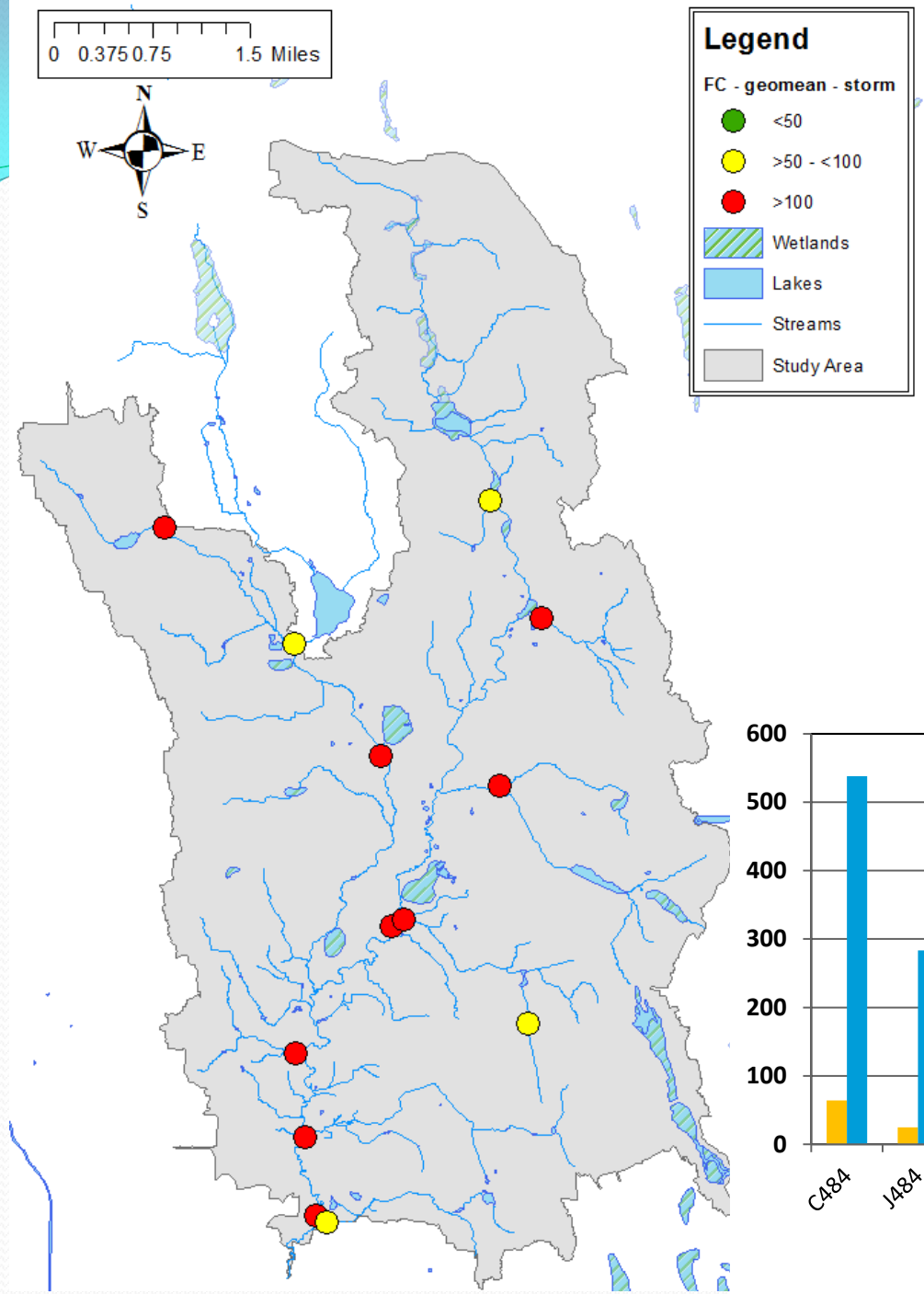
WQ – Dissolved Oxygen

- Of concern throughout watershed

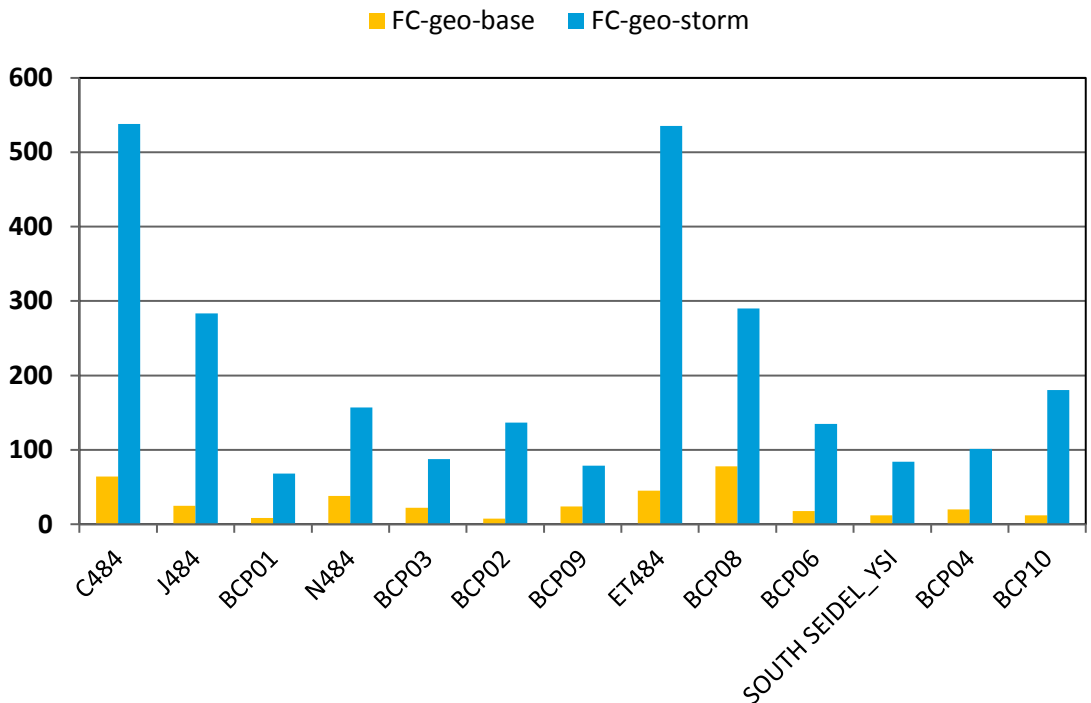


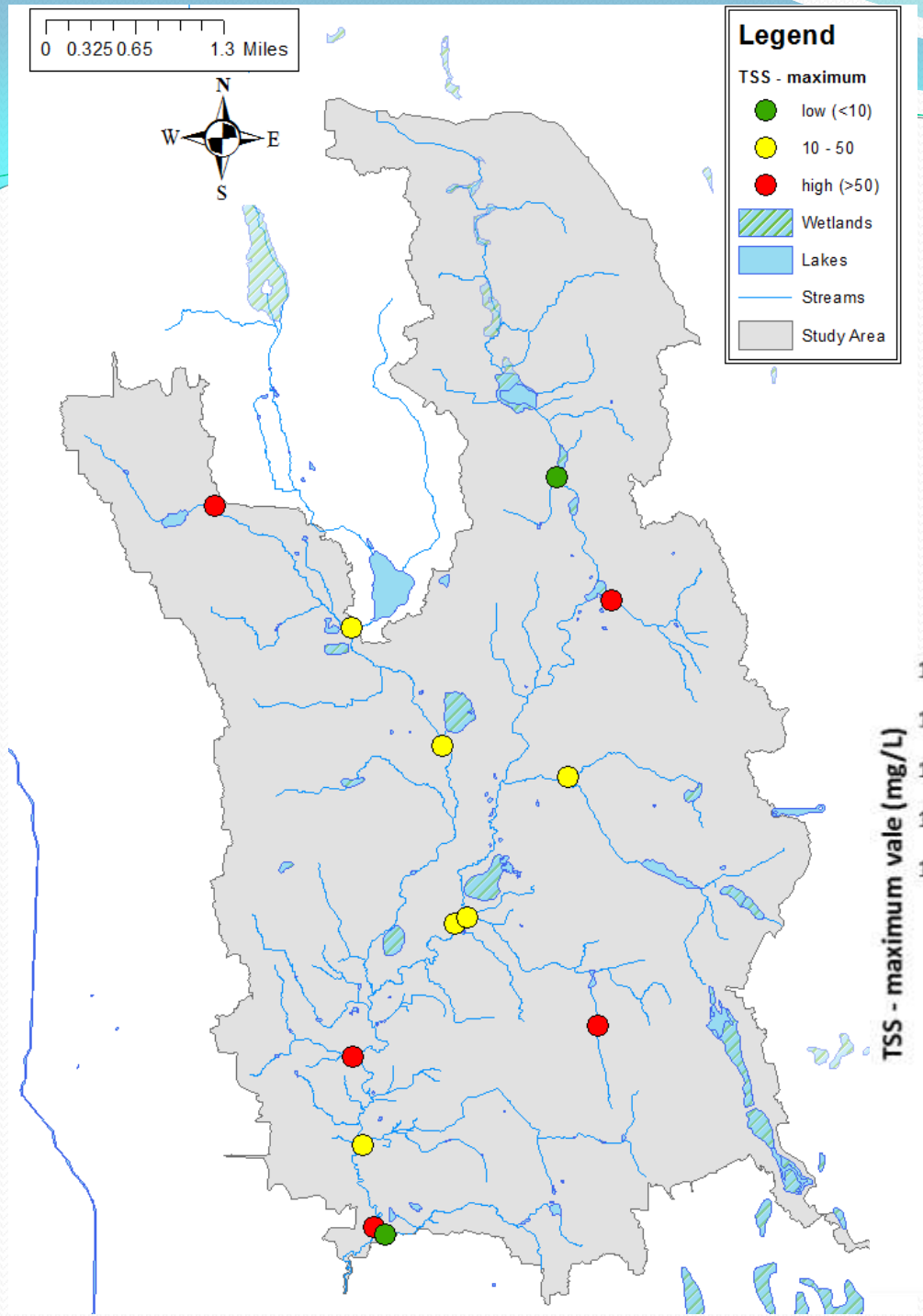


WQ – Fecal Coliform



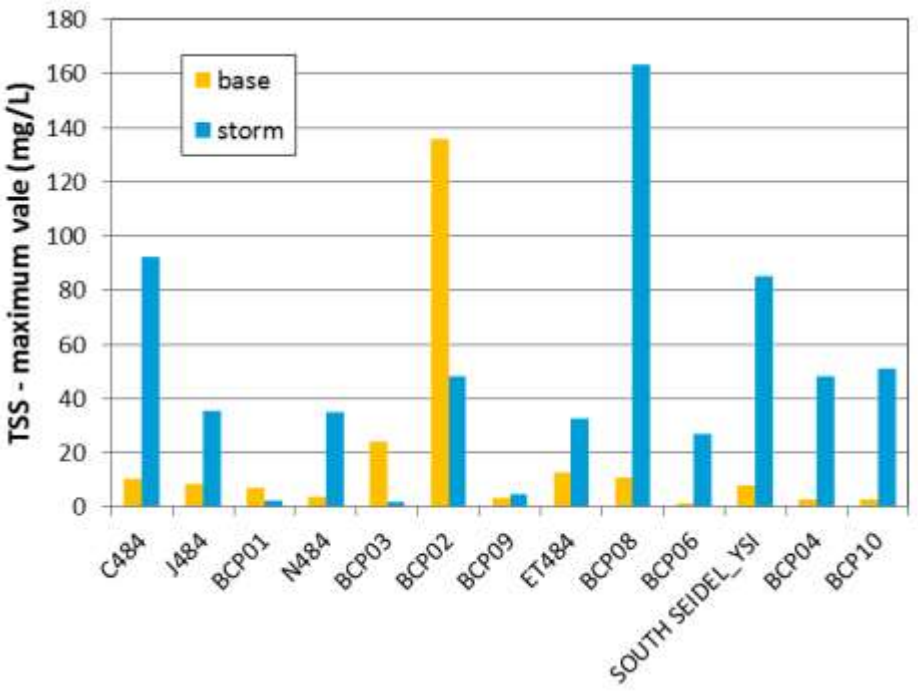
- Storm data over limit
- Only 2 sites have high base FC data
  - Monticello Cr
  - Lower Bear Cr





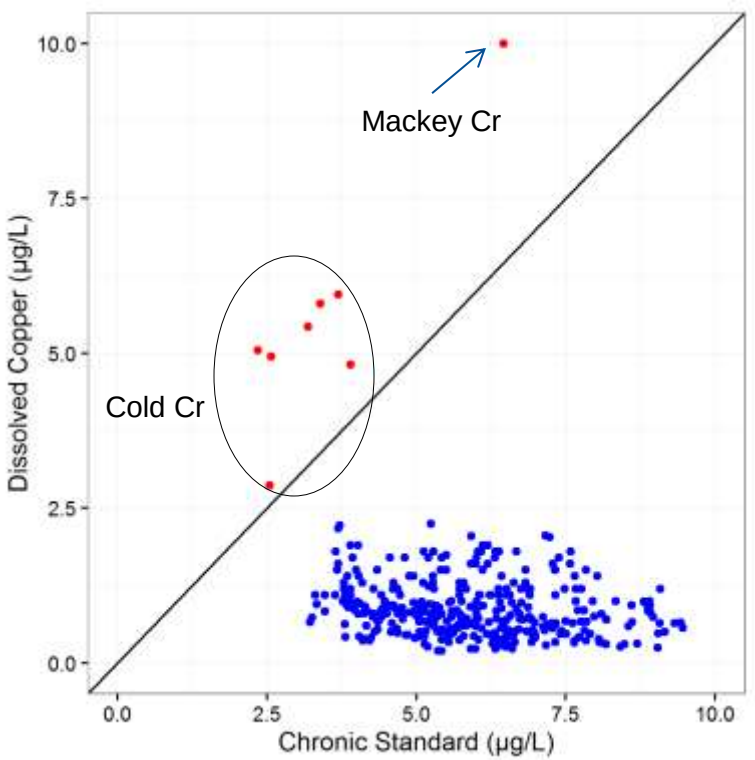
WQ – TSS

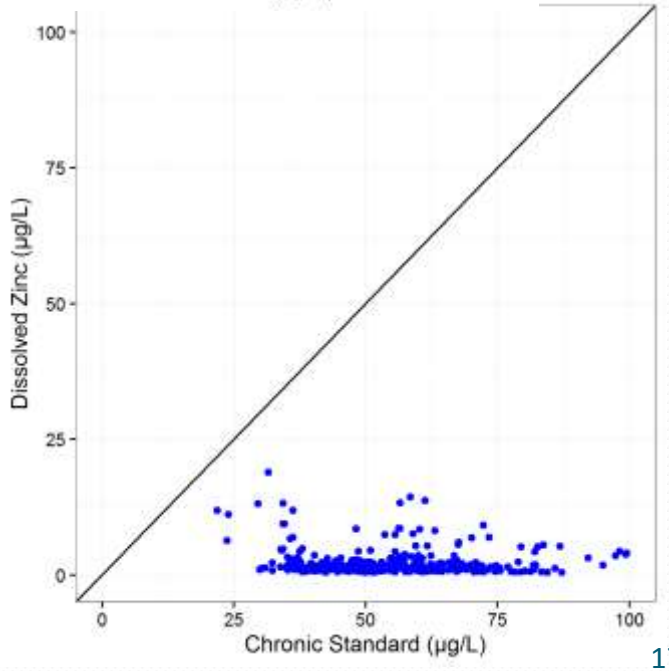
- 5 sites with high TSS
- 2 low TSS (base & storm)
- 3 sites base > storm



WQ – metals

- Copper concentrations exceeded state standards at 2 locations in 2015 storm monitoring
  - Cold Cr
  - Mackey Cr
- Metal concentrations were below state water quality standards thru 2014

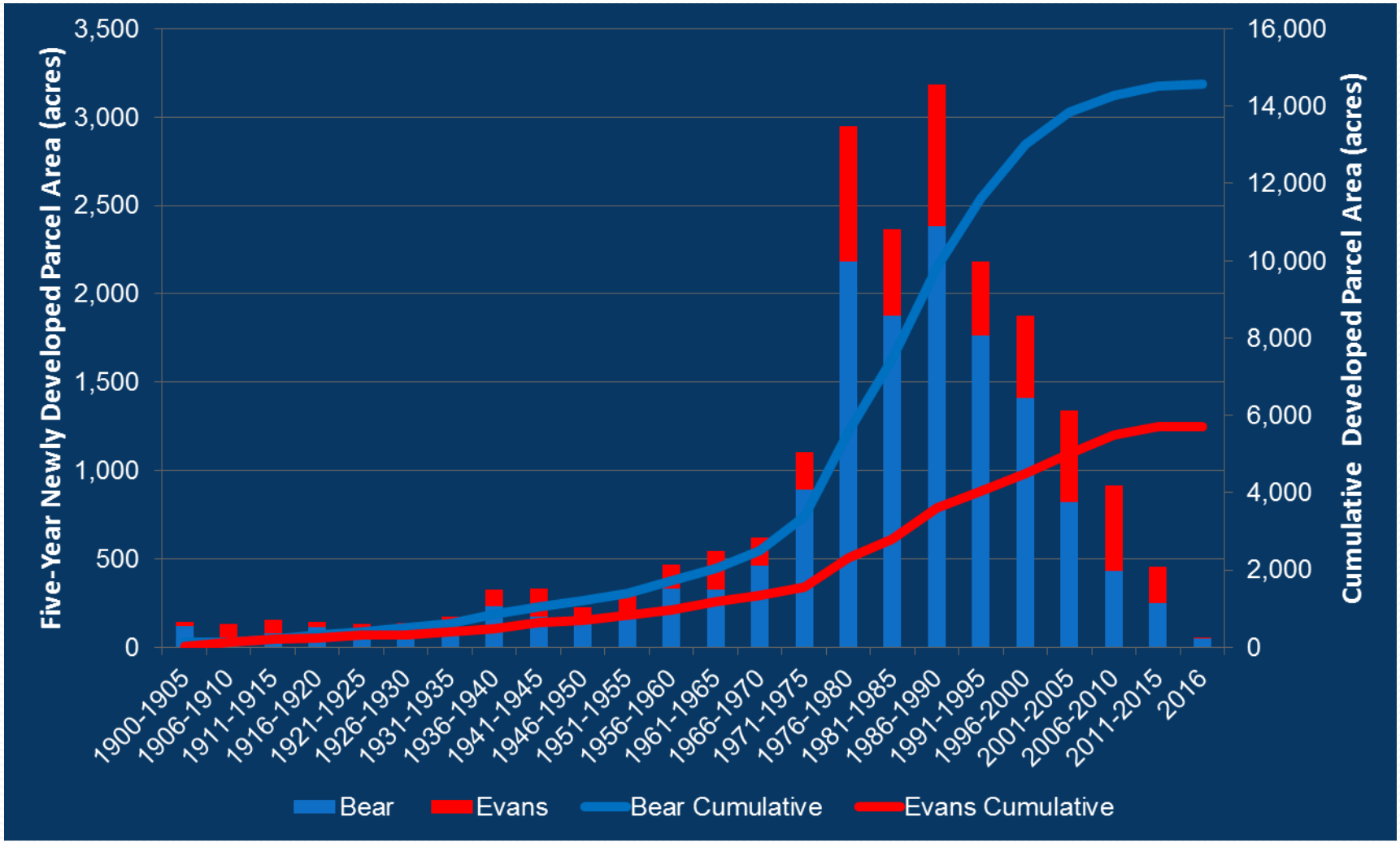




What's Driving Long-term Trends?

- **Why** is water quality **improving**? (nutrients, fecals)
  - Land use change? (agriculture -> suburbs/forest)
  - Bacteria TMDL?
  - Stream stewardship? (livestock exclusion)
  - Land use regulations?
  - Probably **all of the above**
- **Why** is **temperature** and **dissolved oxygen getting worse**?
  - Riparian **deforestation**?
  - **Decreased** cool, **groundwater** input?
  - Increased **organic matter** loading from wetlands in **Evans Creek**?

Urbanization over Time



Conclusions

Parameter	Long-term Trends (1970s to 2015)	Current Conditions
Fecal Coliform	Improving	Not Meeting Standards
Temperature	Degrading	Not Meeting Standards
Dissolved Oxygen	Degrading	Not Meeting Standards
Total Suspended Solids	Improving	Elevated
Nutrients	Improving	NA

- Some water quality improvement, some water quality degradation.
- Basin Plan can identify project solutions for decreasing human health risk (bacteria) and protecting aquatic life (temperature, dissolved oxygen, TSS).

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King County

Patterns of stream macroinvertebrate diversity in the Bear Creek study region

Steve Brady

Bear Creek Technical Webinar

December 12, 2016

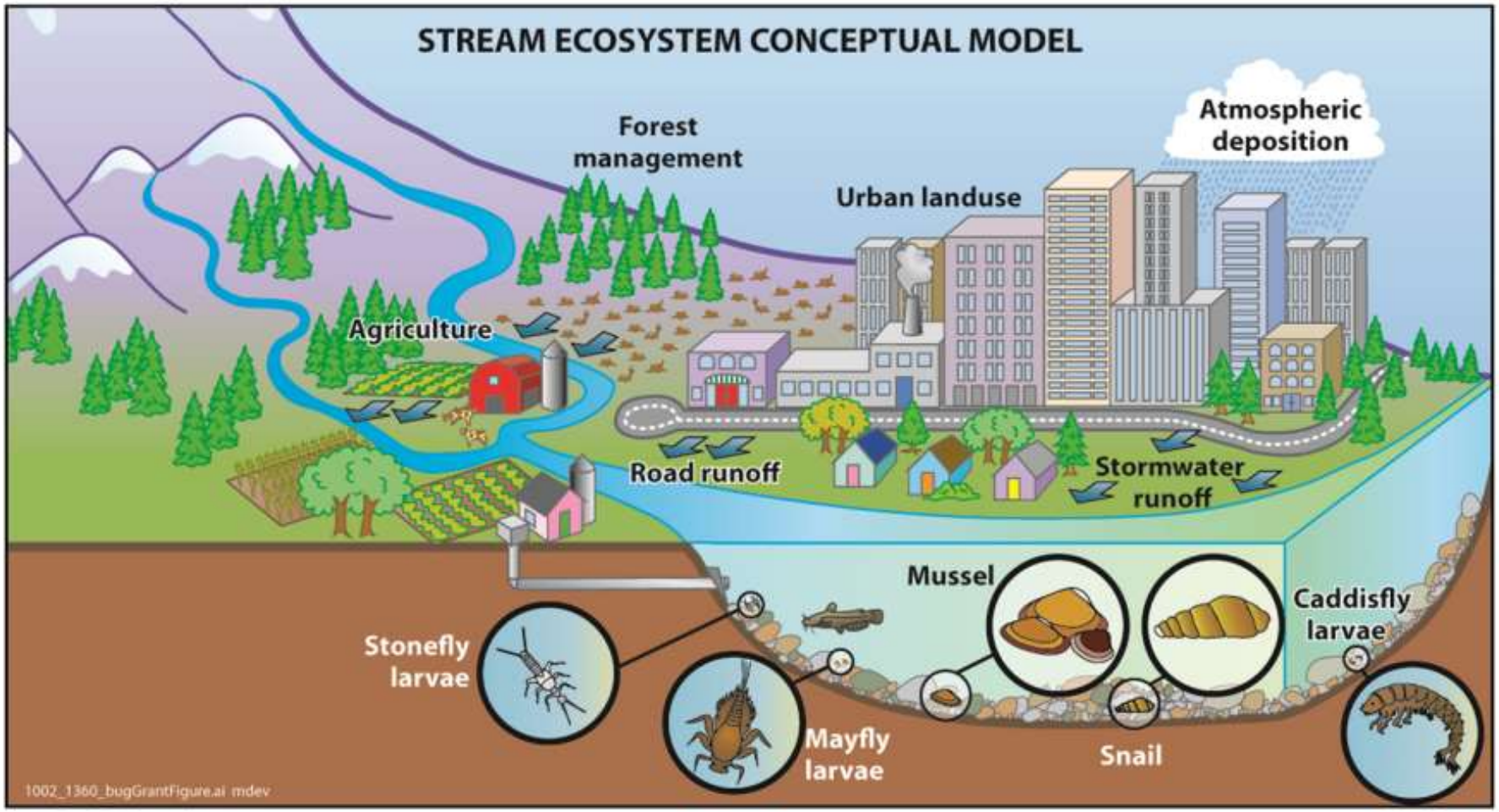
Department of Natural Resources and Parks
Water and Land Resources Division

King County

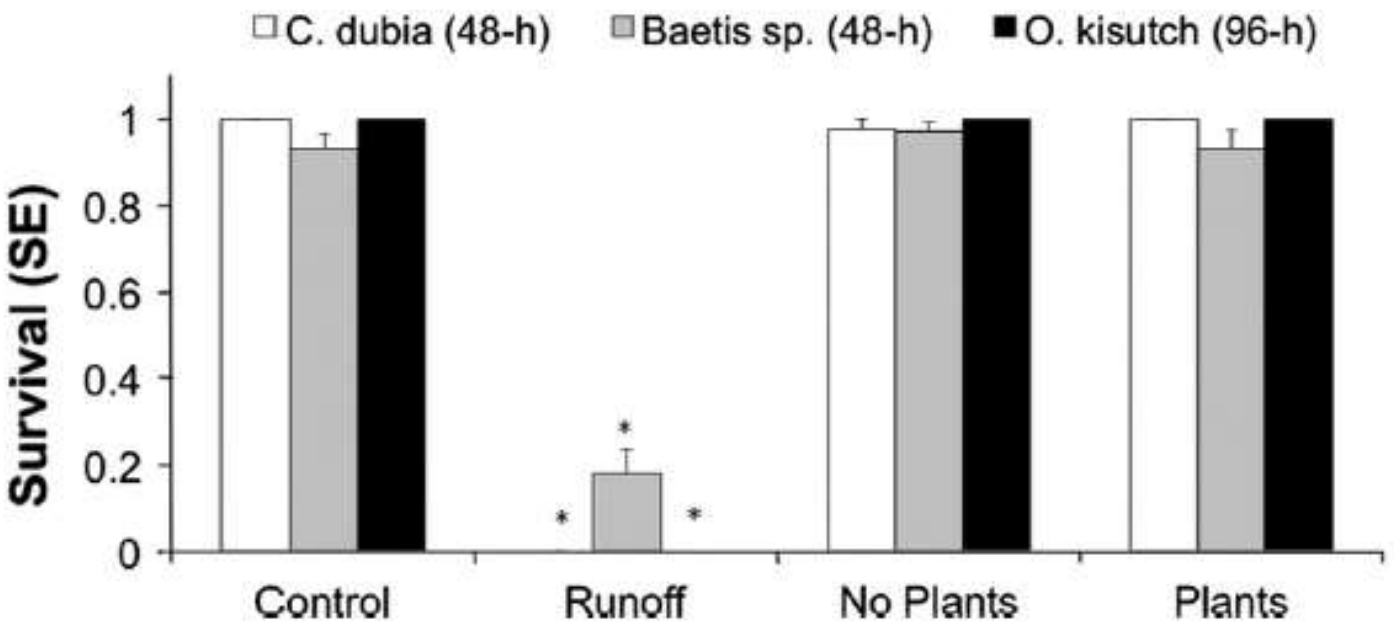
Biotic Integrity

"the ability to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity and functional organization comparable to those of natural habitats within a region" *Karr, 1981*

Benthic Macroinvertebrates Represent Integrated Response



Invertebrates sensitive to contaminants



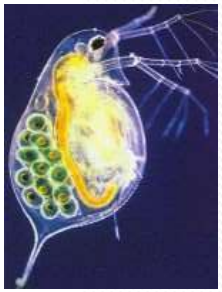


Fig. 4. Survival of three test organisms exposed to control water, untreated September 2012 runoff, runoff treated with bioretention without plants (No Plants), and runoff treated with bioretention with plants (Plants). Asterisks indicate survival significantly lower than control. Error bars are ± one standard error of the mean.

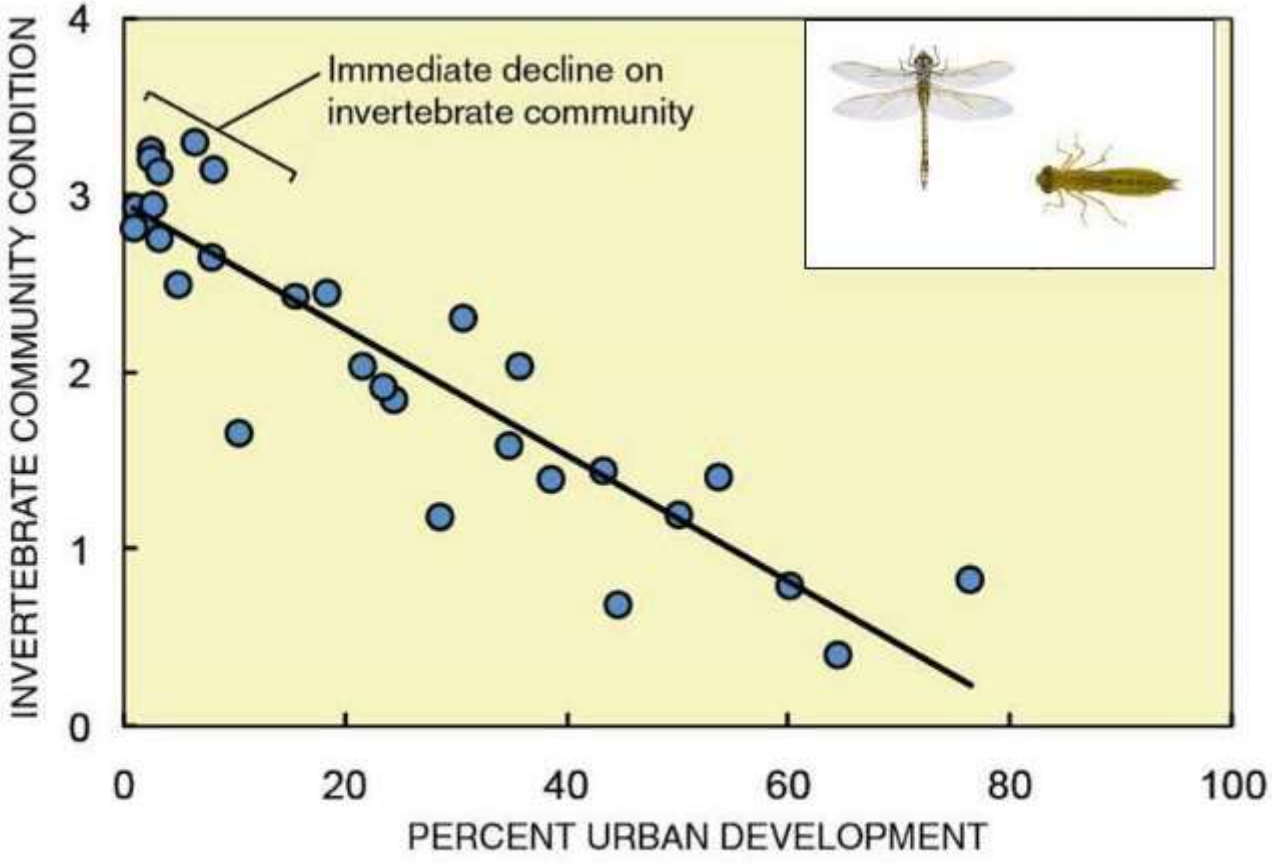
McIntyre et al. 2015 Chemosphere

Invertebrates also sensitive to …

- Instream habitat conditions, especially fines
- Changes in food (leaf litter vs algae)
- Pesticides, especially insecticides
- Non-native plant and animal species
- Fragmented land cover, no pathways for dispersal

- Most of which can be associated with urbanization

Urbanization Diminishes Diversity



USGS

Benthic Index of Biotic Integrity (B-IBI)

Metric
Total Taxa
Mayfly Taxa
Stonefly Taxa
Caddisfly Taxa
Long-lived Taxa
Intolerant Taxa
% Tolerant Individuals
% Predator Individuals
Clinger Taxa
% Dominance

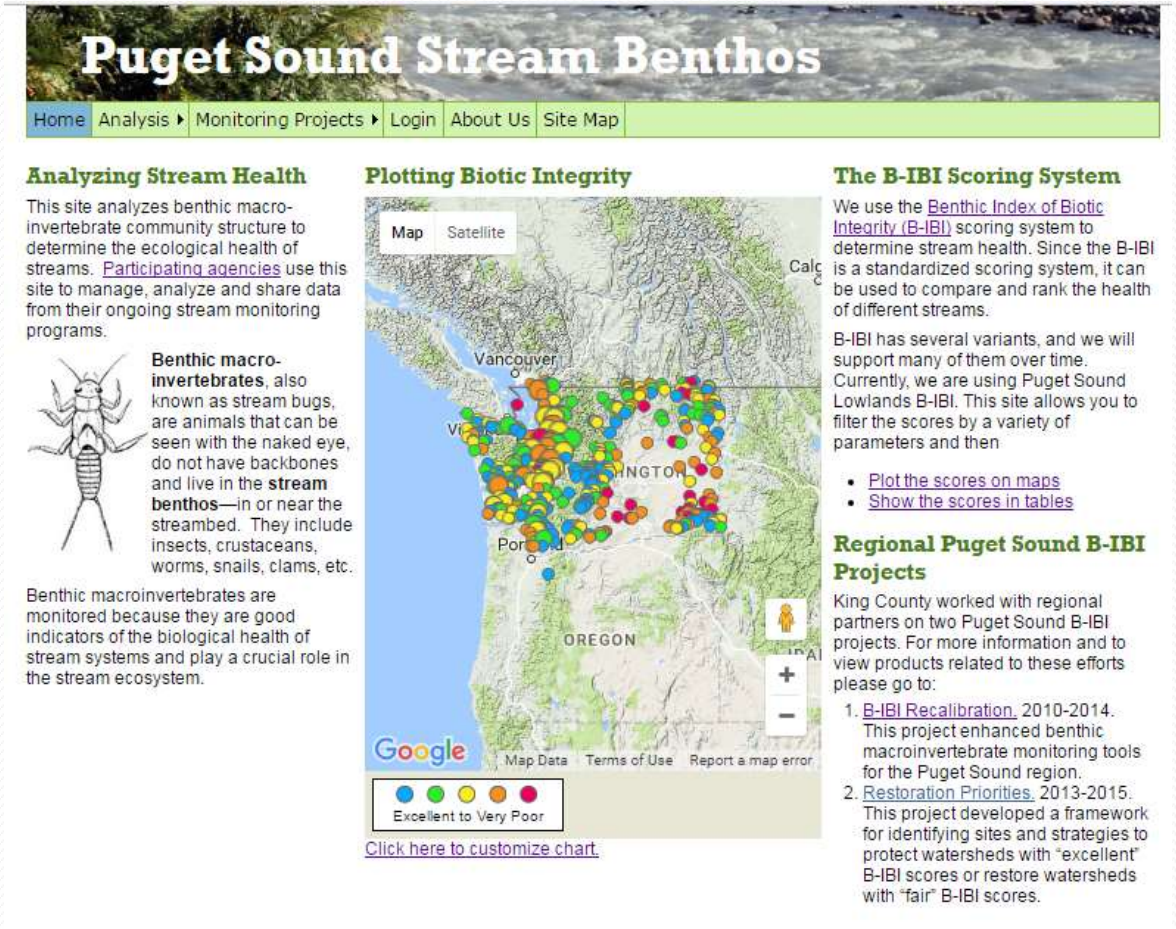
10 Metrics in the B-IBI

- Pollution tolerance/ intolerance
- Taxonomic composition
- Population attributes
- Feeding and habits

B-IBI Condition Categories

Condition of Biotic Integrity	B-IBI$_{10\text{-}50}$ Score	B-IBI$_{0\text{-}100}$ Score
Excellent	46-50	80-100
Good	38-44	60-80
Fair	28-36	40-60
Poor	18-26	20-40
Very Poor	10-16	0-20

Data sourced from PSSB



Many partners collected data

DEPARTMENT OF ECOLOGY
State of Washington

King County

CityofRedmond
WASHINGTON

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

B-IBI has Broader Relevance & Context

Puget Sound Partnership
Vital Sign Indicator

EPA US Environmental Protection Agency

Learn the Issues | Science & Technology | Laws & Regulations | About EPA

National Pollutant Discharge Elimination System (NPDES)

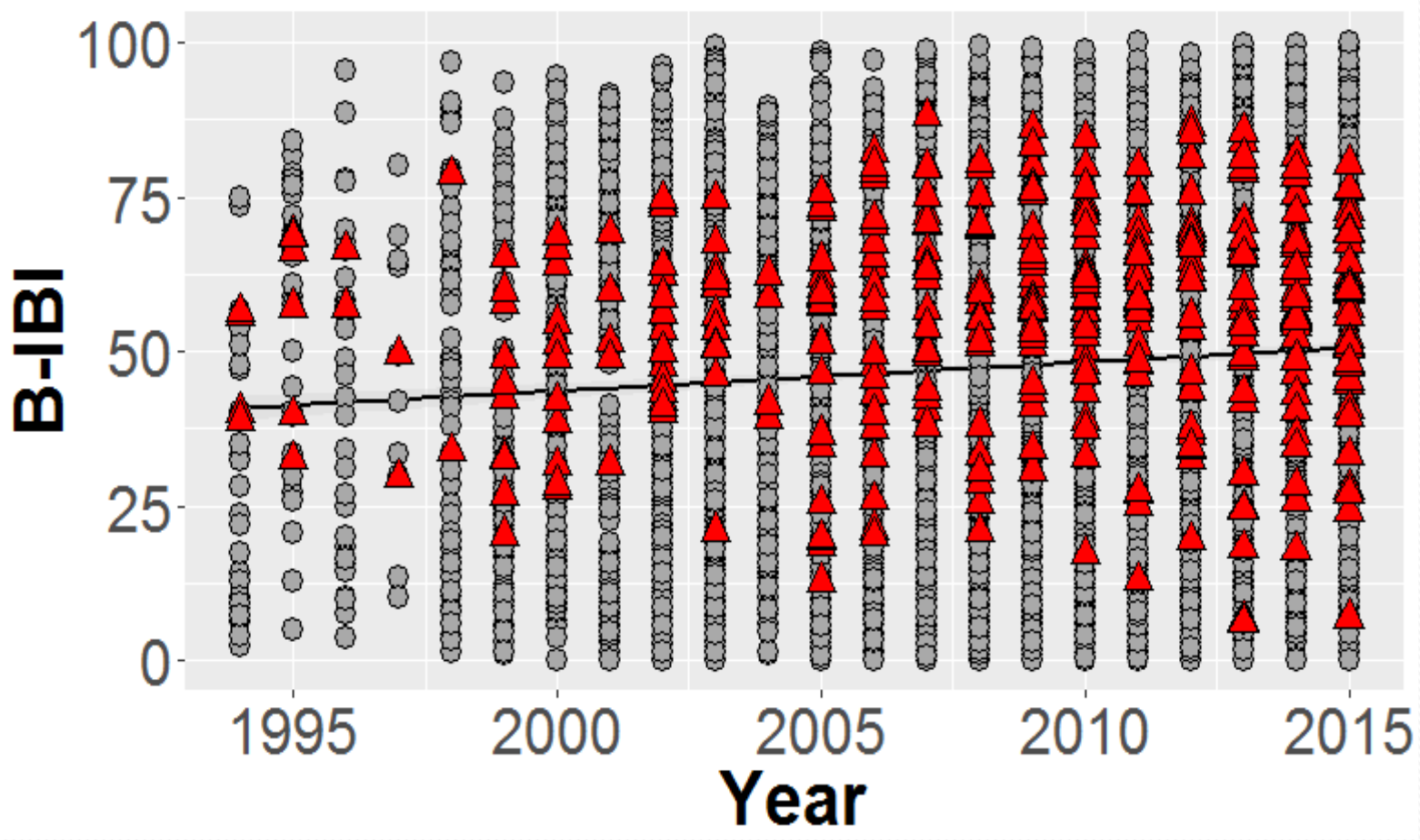
NPDES Home

About NPDES

NPDES Stormwater Program

Supports NPDES
Permitting

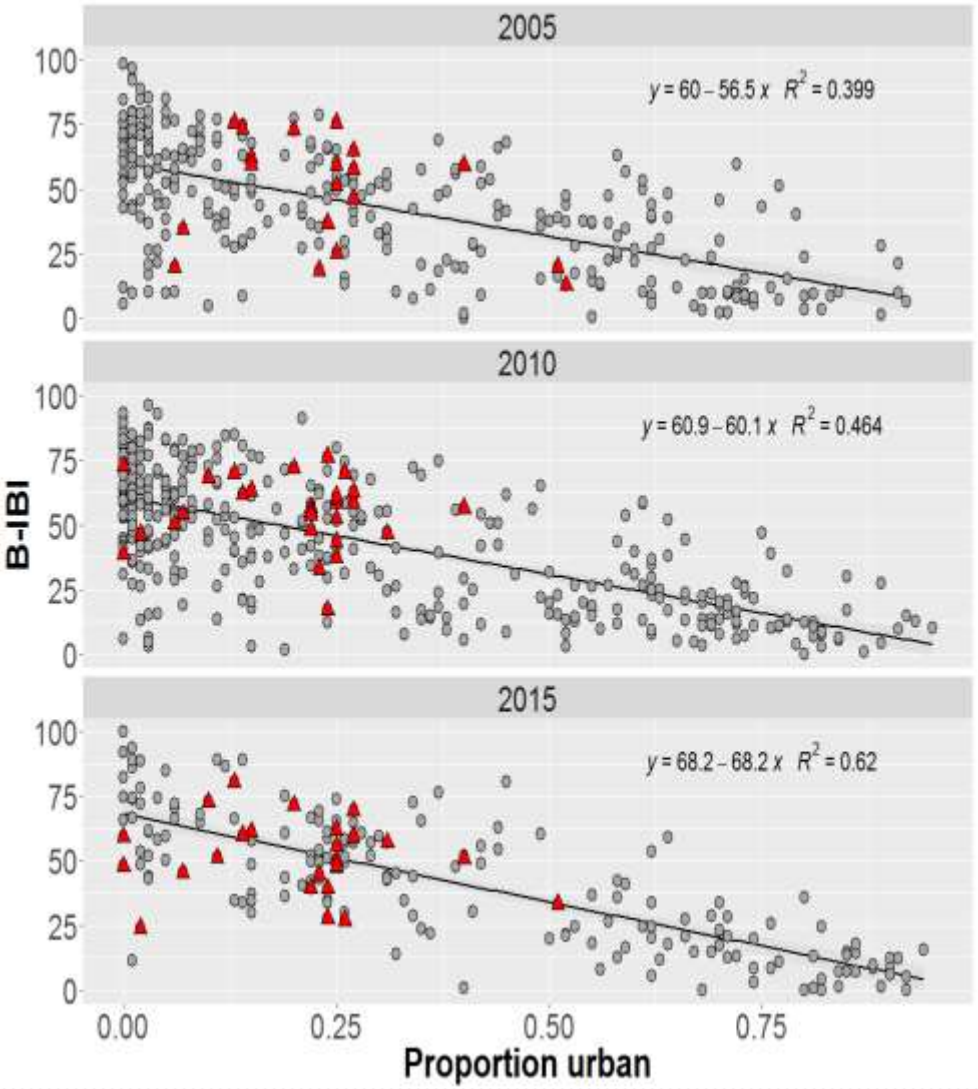
B-IBI Increasing Over Time



Statewide (○) and Study area (△)

- ½ point per year increase

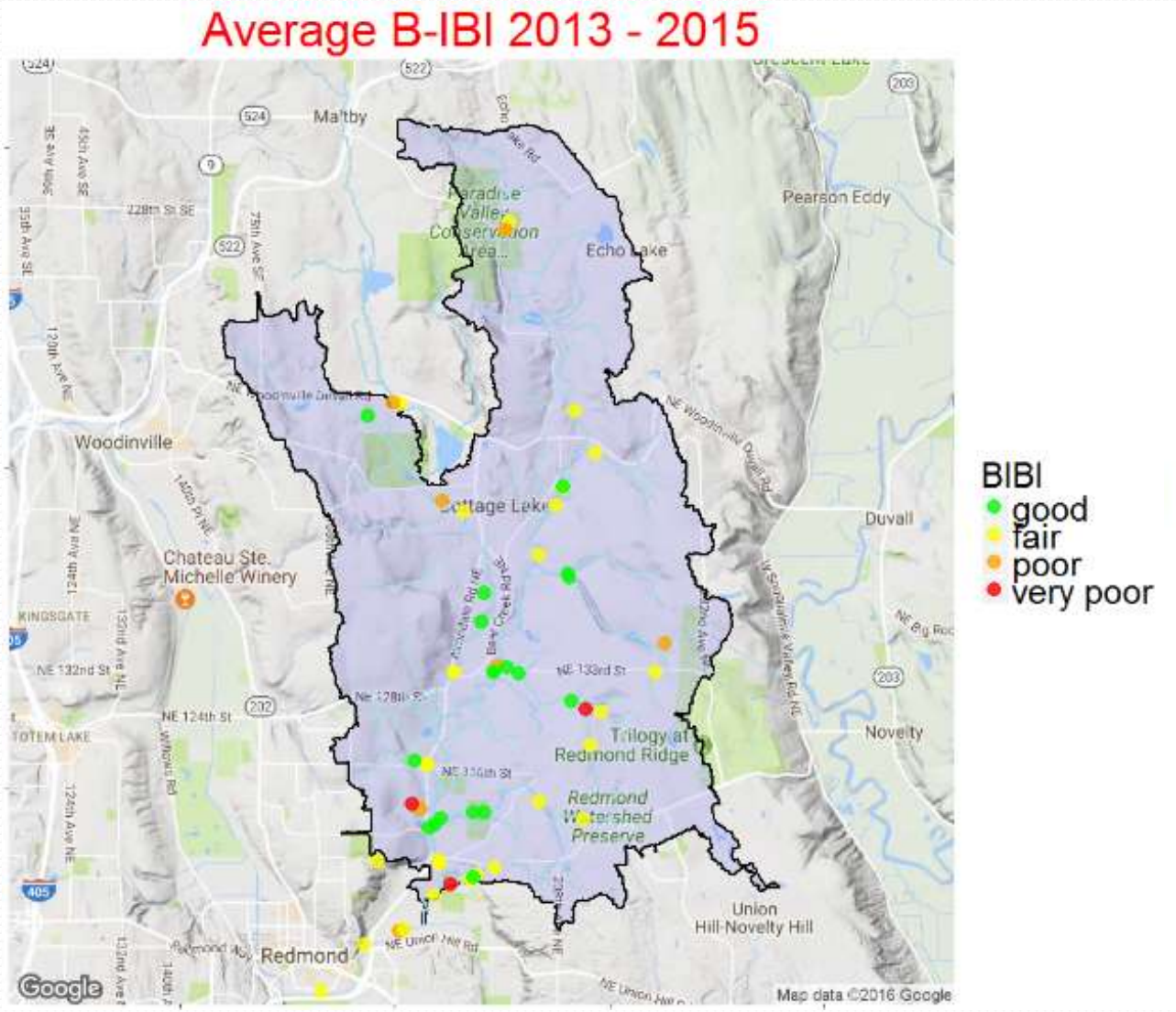
Urbanization degrades B-IBI

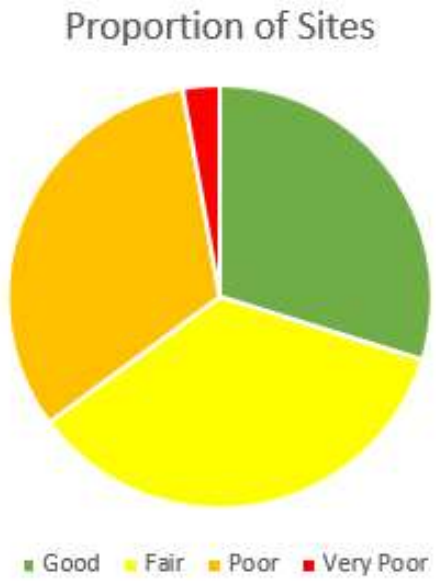


Statewide (○) and study area (▲)

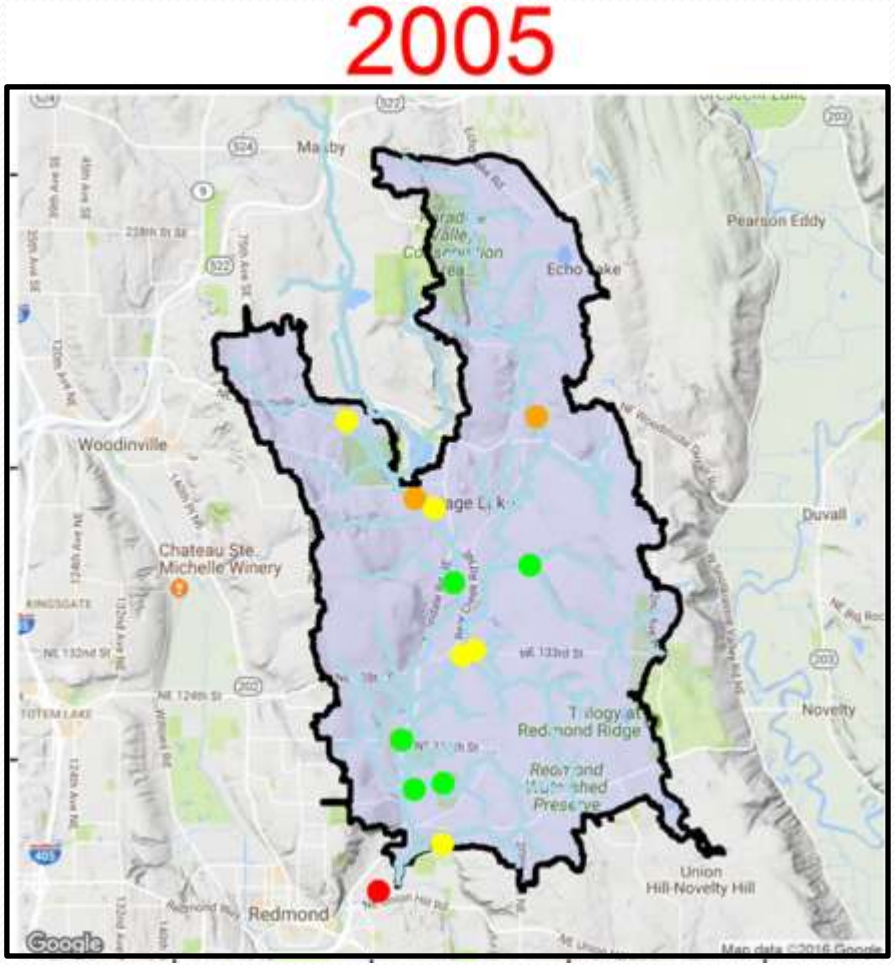
- Strong negative effect
- High variation (e.g. undeveloped sites can have low scores)
- Annual variability

B-IBI Current Conditions



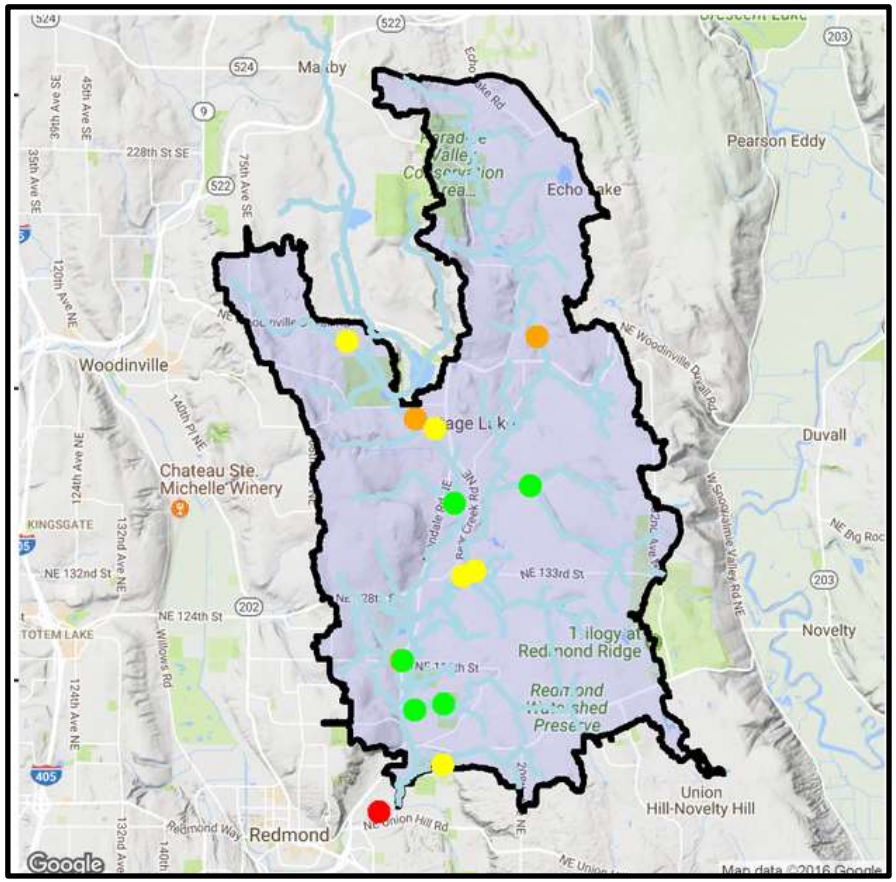


B-IBI is Dynamic

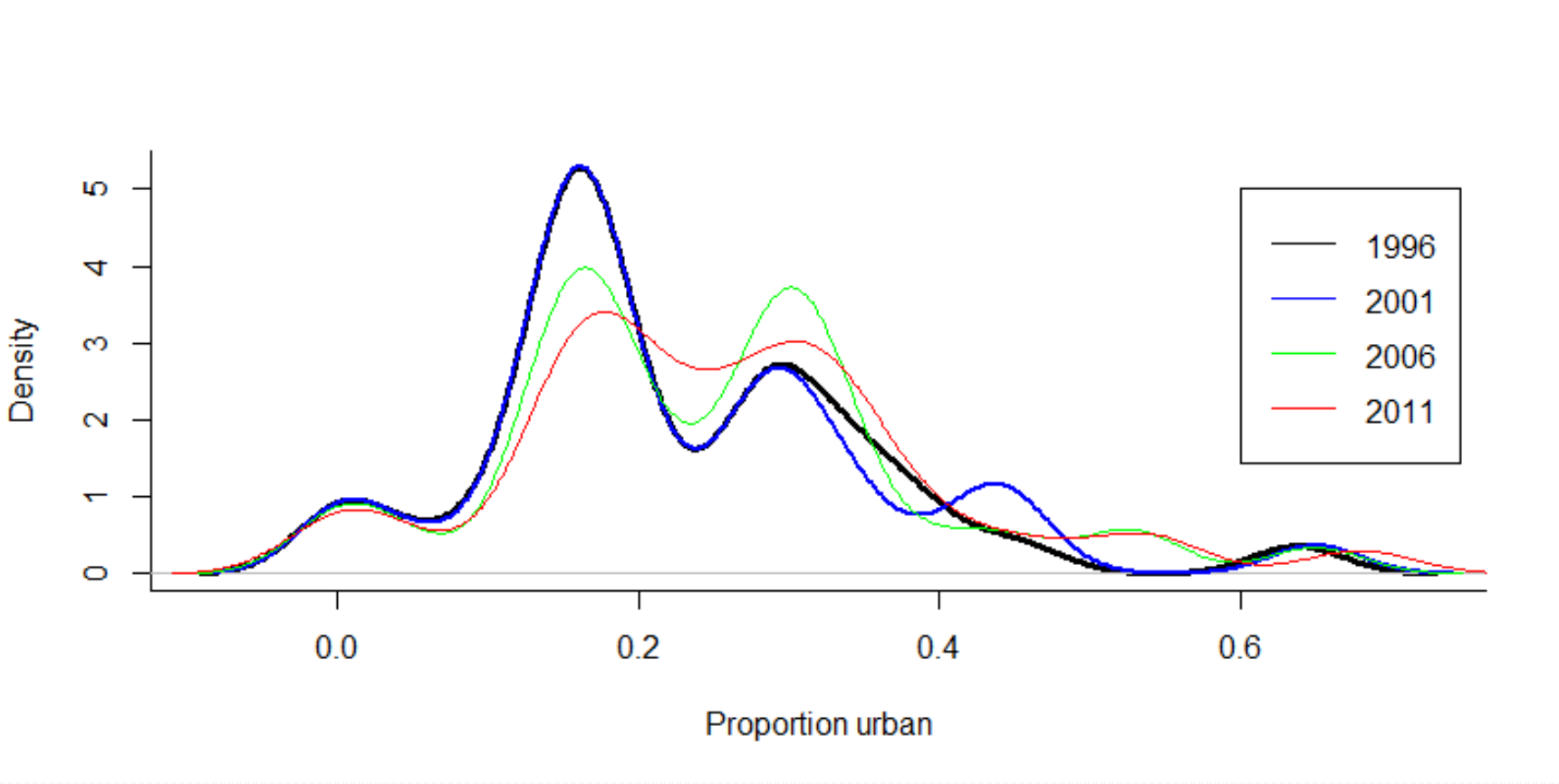


B-IBI is Dynamic

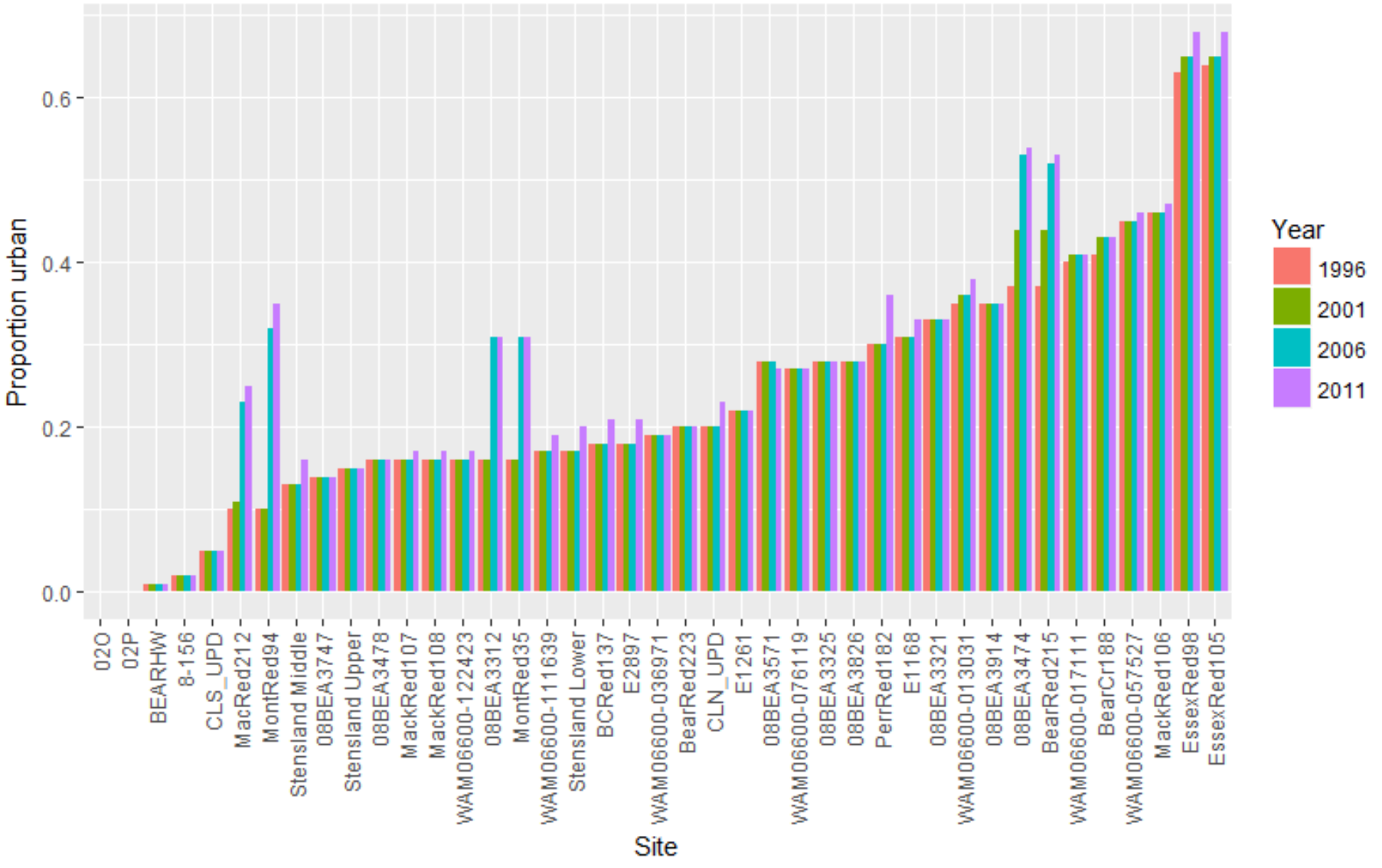
2005



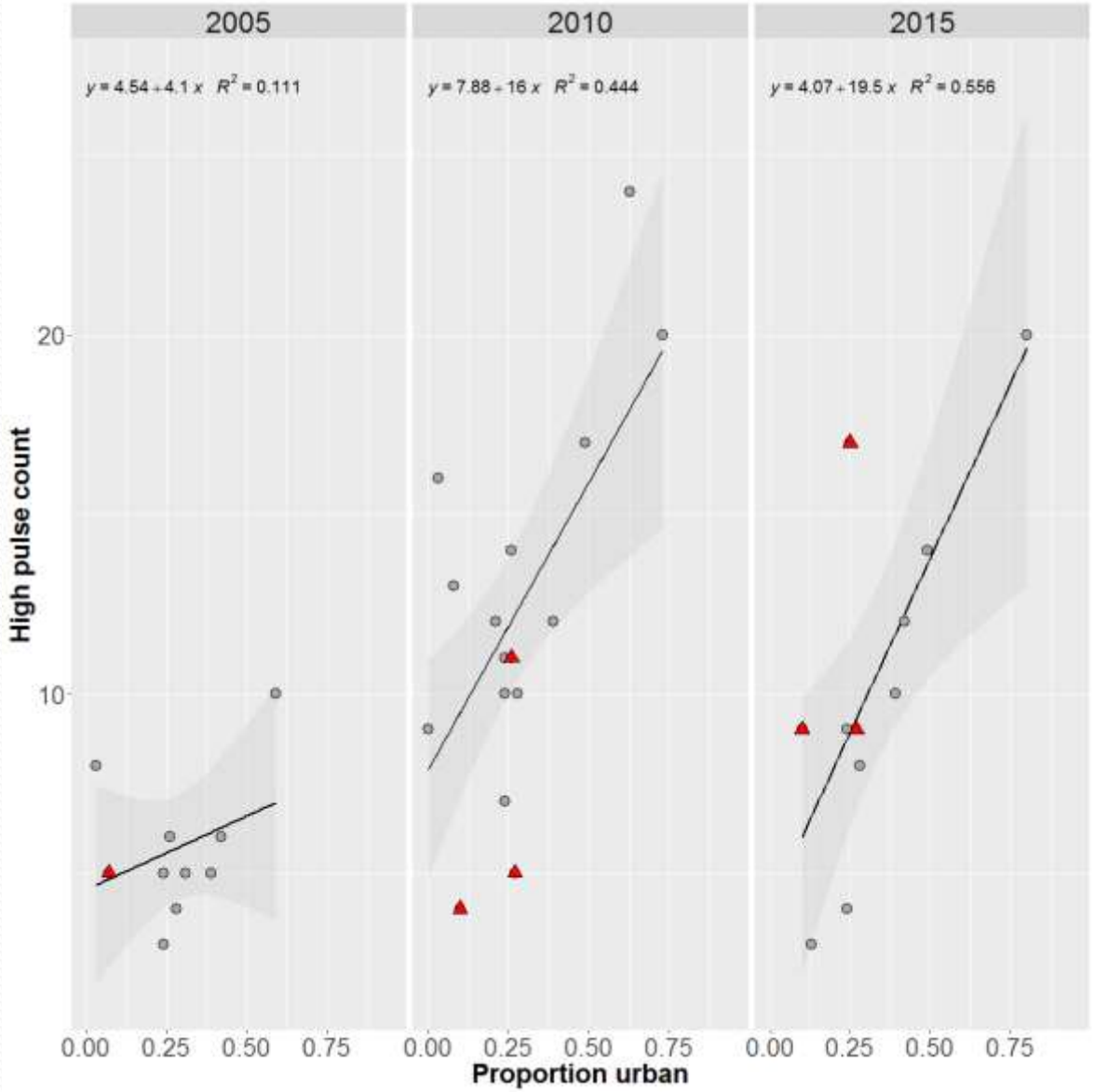
Urban Areas Increased in Study Area



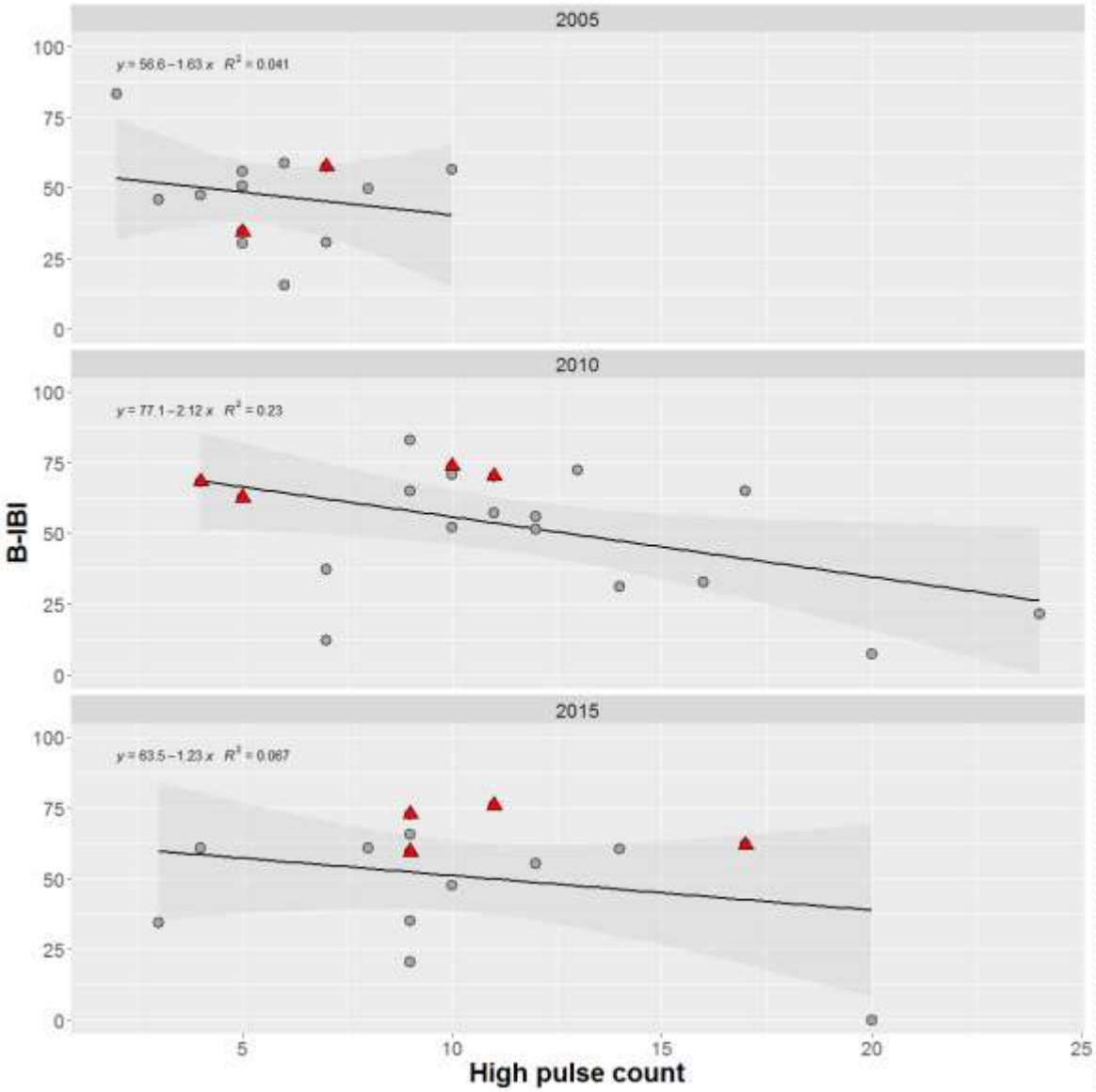
Increased Urban Cover in Study Area



Urbanization Increases Flashiness



Flashiness Degrades B-IBI



B-IBI Improved in Some Sites

B-IBI Stable/Deteriorated in Others

Summary

- Slight increase in B-IBI statewide over 20 years
- But still not at desired levels B-IBI strongly influence by urbanization
- Many sites in Study Area have declining B-IBI
- Flashiness increases with urbanization and deteriorates B-IBI
- Reducing flashiness may contribute to improved B-IBI in the future

Q

A

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King County

Assessment of Bear Creek Watershed Wetlands

Jen Vanderhoof

Bear Creek Technical Webinar

December 12, 2016

Department of Natural Resources and Parks
Water and Land Resources Division

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The importance of wetlands

Wetlands perform a wide array of ecological functions and environmental benefits:

- water purification
- flood protection
- groundwater recharge
- streamflow maintenance
- valuable habitat for fish and wildlife

Important part of watershed hydrology

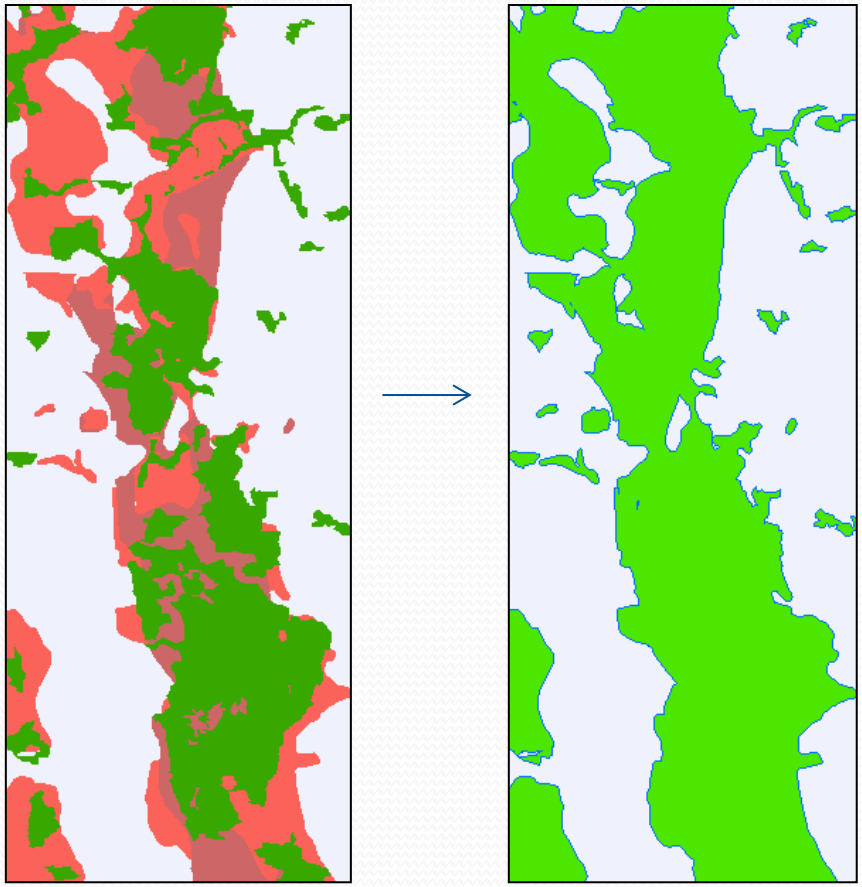
Objectives of the wetland assessment

- Report on current conditions.
- Estimate change in wetland presence over the past 25-35 years.

Determining current conditions

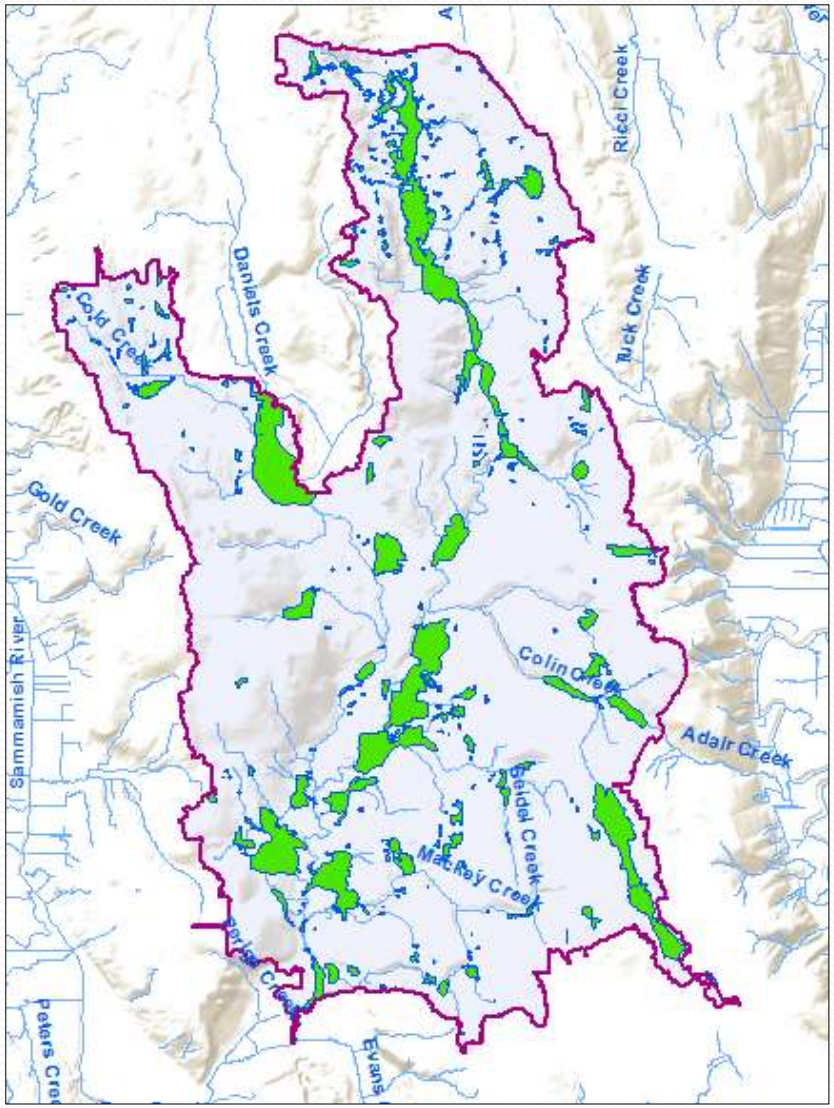
- Must rely on GIS data for wetland assessment
- Available data:
  - King County Wetland Inventory; 1981; 1990
  - National Wetland Inventory; 1983-84
  - King County permit application data ("CAO" wetlands); 2005-13
  - Snohomish County; ~2011
  - City of Woodinville; 2006-2007 plus other
  - City of Redmond
- No wetland datasets are complete or fully accurate

Multiple datasets complicate inventory

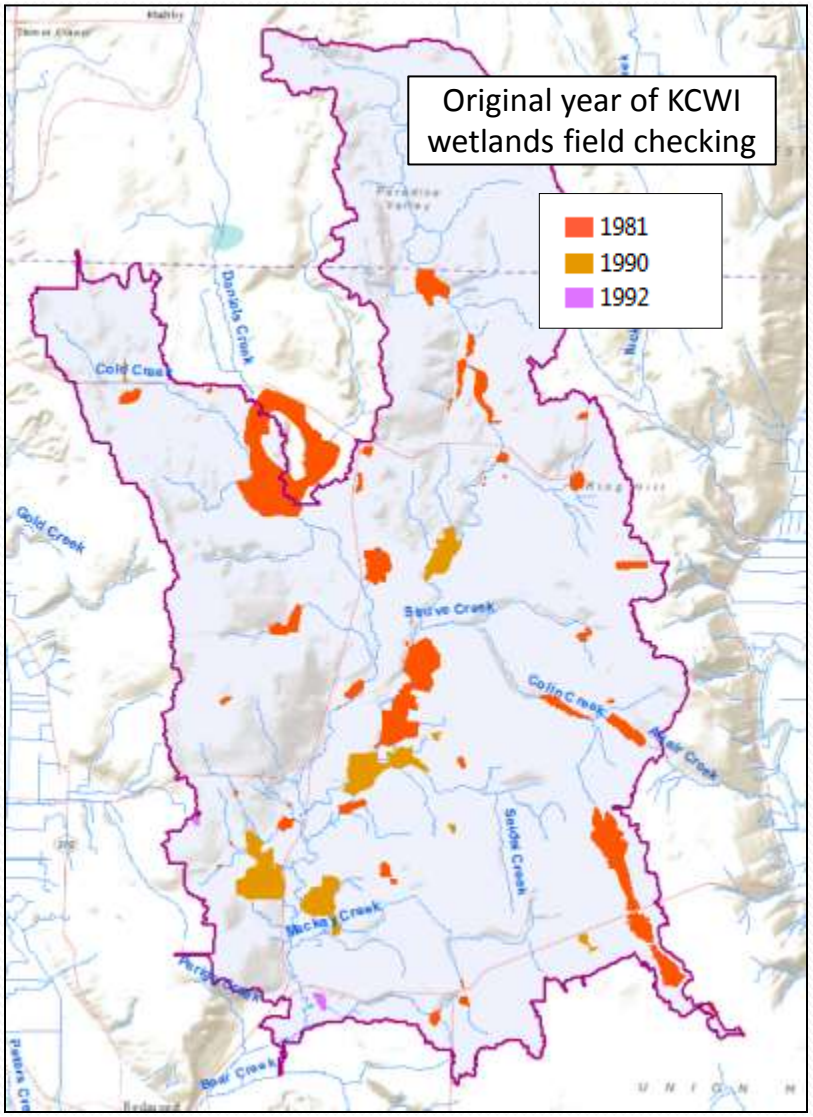


- All overlapping wetlands were merged to simplify the analysis

Results of data merge



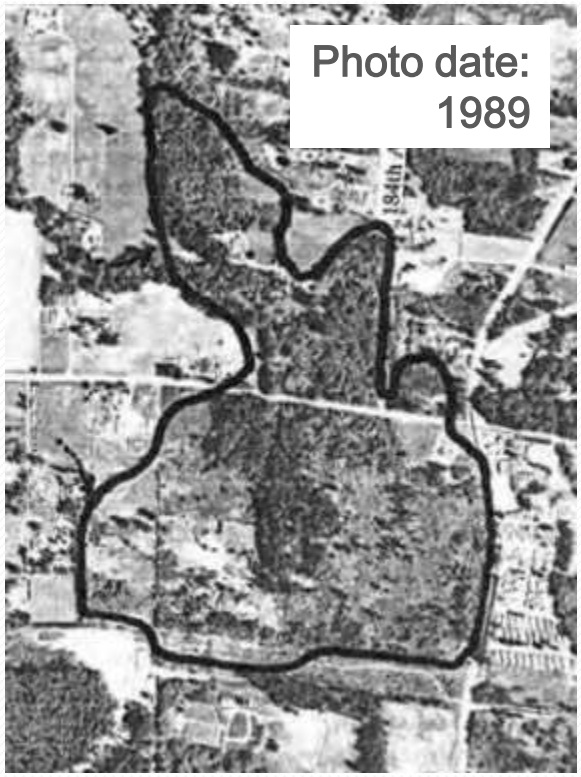
- Approx. 330 mapped wetlands
  - ~90 in Sno Co & ~240 in King Co
- 1693 acres total
- Wetland identification errors:
  - Likely many more wetlands in the watershed that are not mapped (errors of omission).
  - Not all mapped wetlands have been verified to actually be wetlands (errors of commission).



Losing wetlands?

- Need reliable data for change analysis
- Subset of 54 KCWI wetlands selected for use as baseline:
  - original presence field verified
  - not delineated
  - inventory built over several years

Change analysis



1990 survey: 87 acres

2015 aerial: 60.3 acres

- Visual then-and-now comparisons
- All developed areas cut out of original polygon
- Undeveloped acreage may or may not be wetland

Results: 2015 compared to baseline

Observable change from aerial photos:

- 20% (11 out of 54) of baseline wetlands were visibly altered since 1981-1990.
- 9 of the 11 wetlands with loss were intact in 1990, when the SAO was passed.
- This subset shows loss to mapped wetlands over past ~35 years.

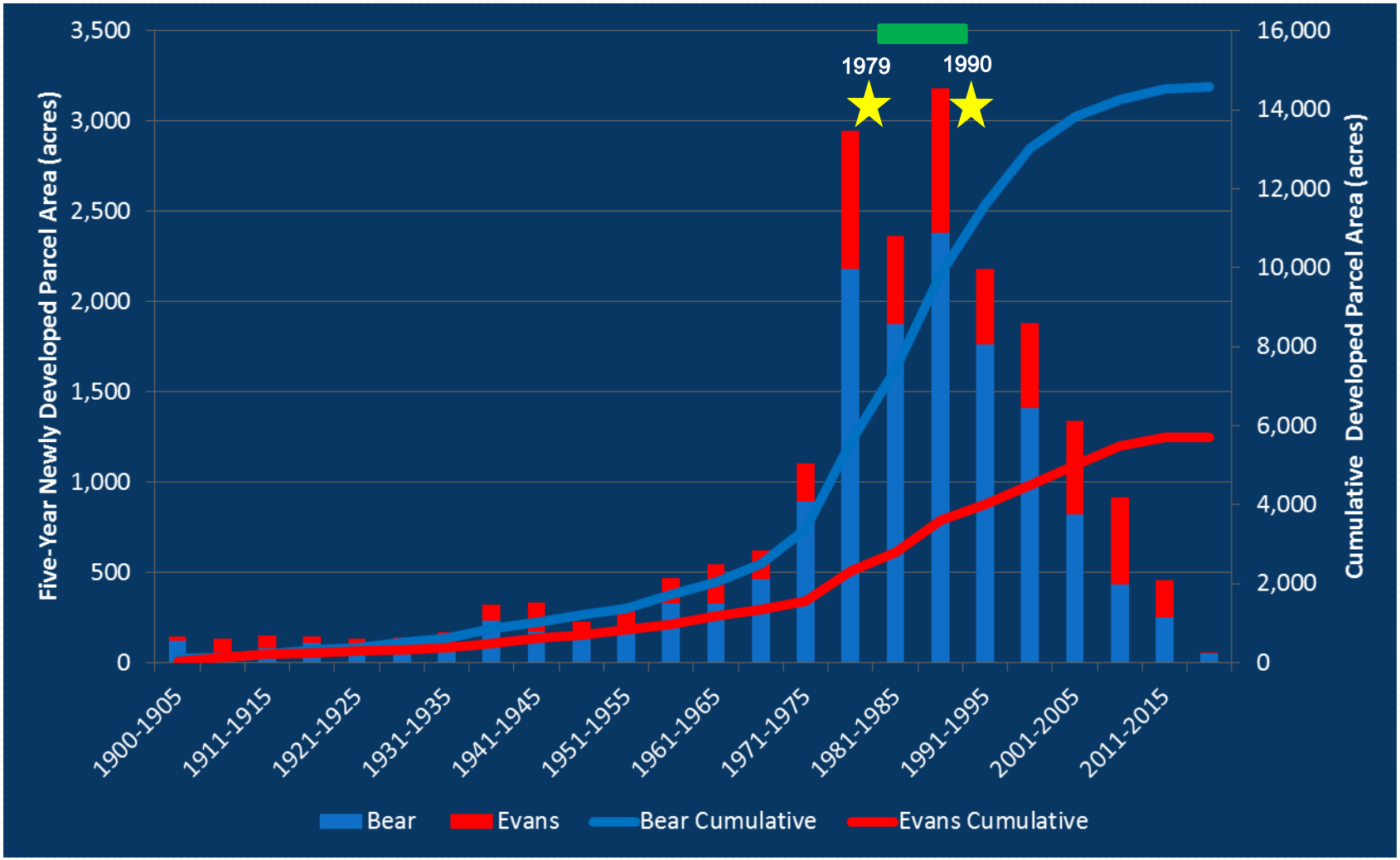
Errors of omission

Of the 68 “CAO wetlands” currently in the watershed in GIS:

- 31% (21 out of 68) overlap KCWI or NWI wetlands.
- 47 (69%) do not and are not in immediate vicinity.
  - These previously undetected wetlands tend to be small or forested.
  - Results suggest there are unmapped small or forested wetlands.

Gone without a trace: It’s possible/likely that prior to regulations in ~1990 that many unmapped wetlands were filled.

Urbanization & wetlands



Wetlands Analysis Summary

- Wetlands are important because of their role in the watershed's hydrology & ecology
- Approx. 330 mapped wetlands in watershed & likely many more unmapped wetlands
- Change analysis shows loss to development
  - 20% of baseline wetlands were visibly altered since 1981-1990
- Limitations of available data likely leads to under-reporting of loss

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King County

Riparian Assessment

Jen Vanderhoof

Bear Creek Technical Webinar

December 12, 2016

Department of Natural Resources and Parks
Water and Land Resources Division

King County

The importance of riparian areas

Healthy riparian areas, defined as being vegetated in native trees and shrubs, are important because they:

- improve water quality by helping filter pollutants
- reduce stream bank erosion

Important part of watershed hydrology

- increase shade, which lowers water temperatures, which in turn support the higher dissolved oxygen levels
- provide a source of large wood to the streams, which increases instream habitat complexity
- provide over-hanging vegetation, which creates a source of invertebrates to the streams

Benefit salmon & system ecology

Objectives of this riparian assessment

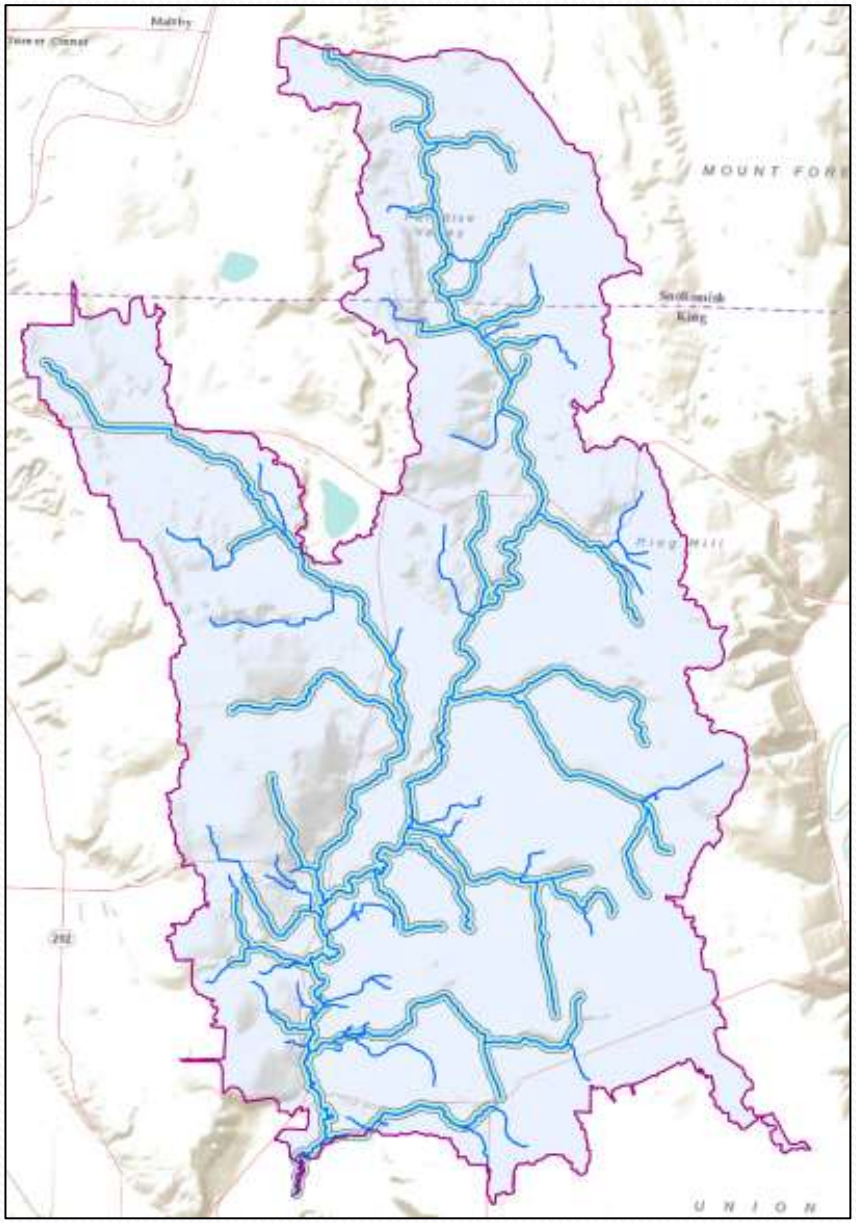
- Report on current conditions.
- Examine changes in riparian land cover over time.

How wide a corridor to study?

Regulatory context (each defined by jurisdiction)

- Critical Areas: stream riparian buffers
  - 165 ft in King Co.
  - 150 ft in Snohomish Co.
- Shoreline Management jurisdiction
  - Minimum of 200 feet from OHWM of streams > mean annual flow of 20 cfs
  - Shorelines of statewide significance

- 400 ft corridor selected to study –
  200 ft on each side of stream center-line



Which streams?

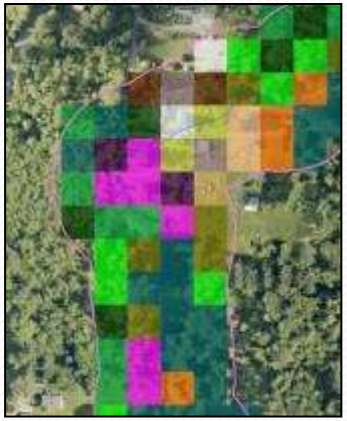
Stream extent in study area:

- 65.6 total stream miles
- 46.7 miles of stream with confirmed or potential salmon presence

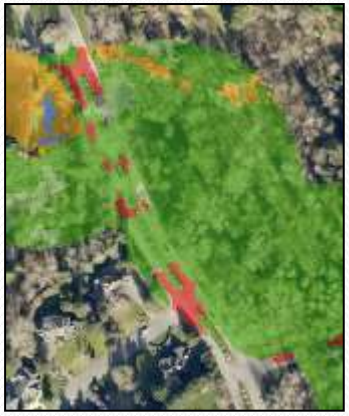
Need good data

- External (non-King County) land cover datasets:
  - National L tabase (NLCD coverag
  - Coasta hange An is ogram – 2011 (CCAP coverage).
  - WDFW d 1 and 2013 (missi portio of the n thern basin).

Wrong scale



Too much error

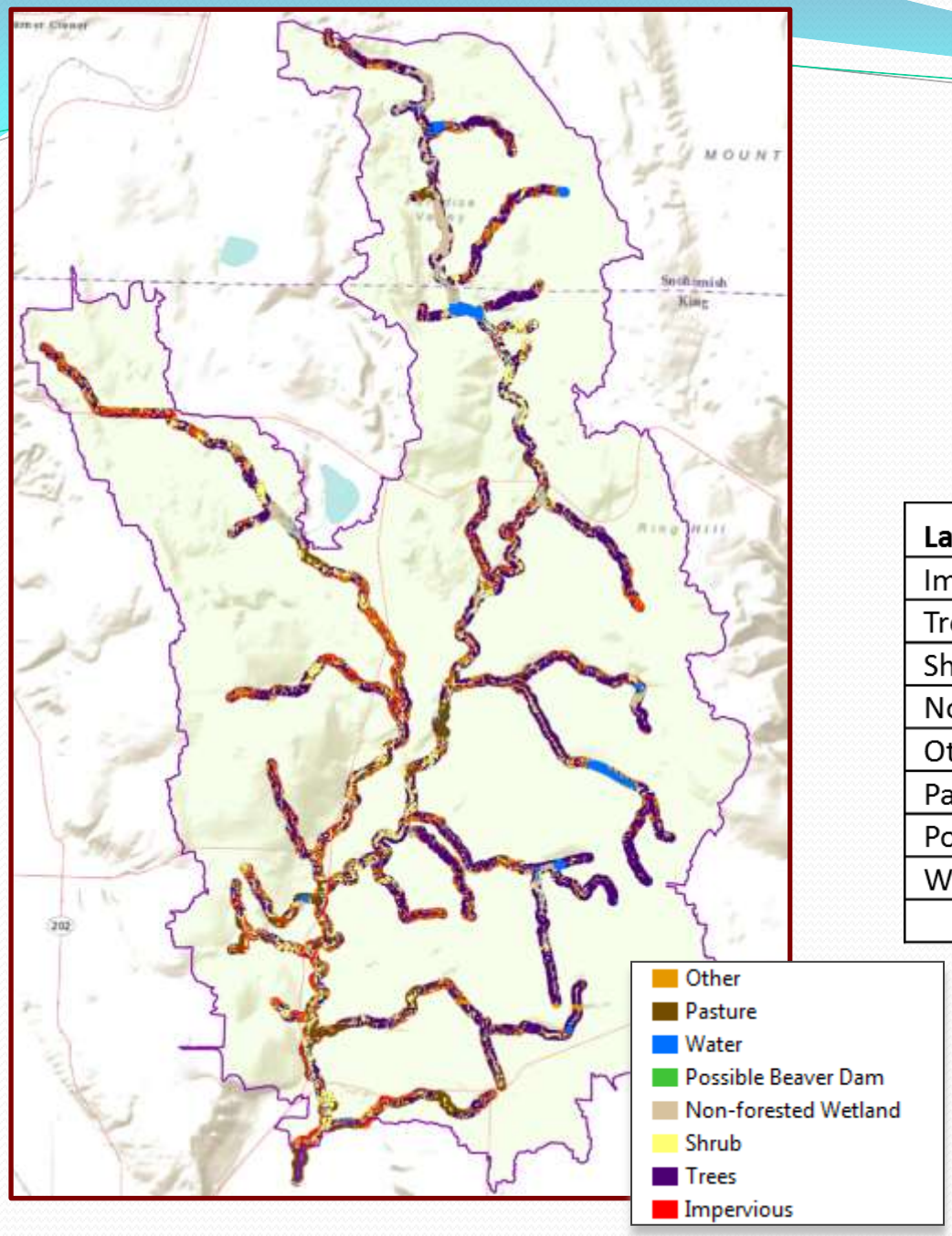


Good data!

New dataset:

- WDFW data as foundation for:
  - Forest
  - Impervious
- Drew in:
  - Shrub
  - Pasture
  - Non-forested Wetland
  - Water
  - Possible Beaver Dam
  - Other
- Hand-corrected on multiple passes

Current riparian land cover

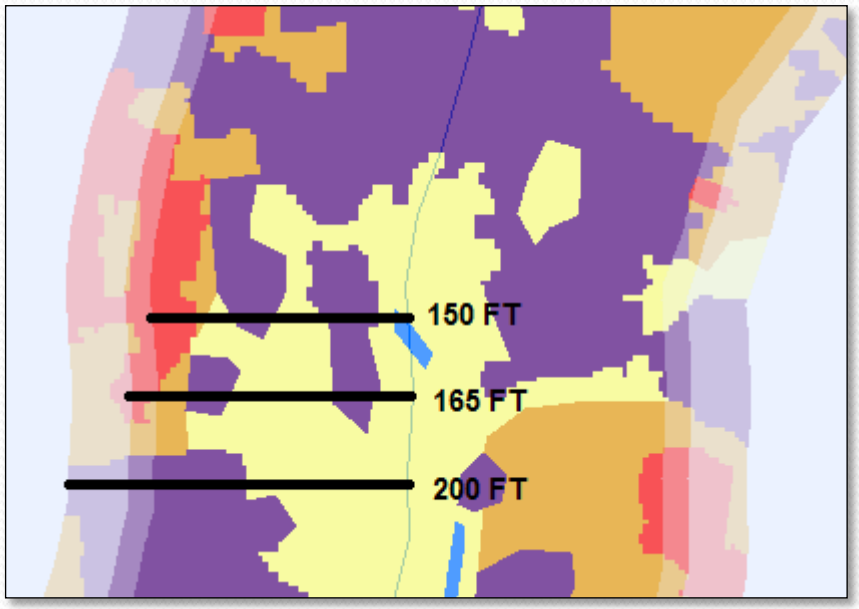


400-ft corridor results

Land cover class	total acres	percent
Impervious	151.1	6.9%
Trees/Forest	1016.3	46.4%
Shrub	398.2	18.2%
Non-forested Wetland	116.2	5.3%
Other*	270.6	12.4%
Pasture	153.1	7.0%
Possible Beaver Dam	0.6	0.03%
Water	84.2	3.8%
Total	2190.3	

* Other: lawn/yard/landscaping, bare area, certain gravel surfaces, mud, and mowed roadside.

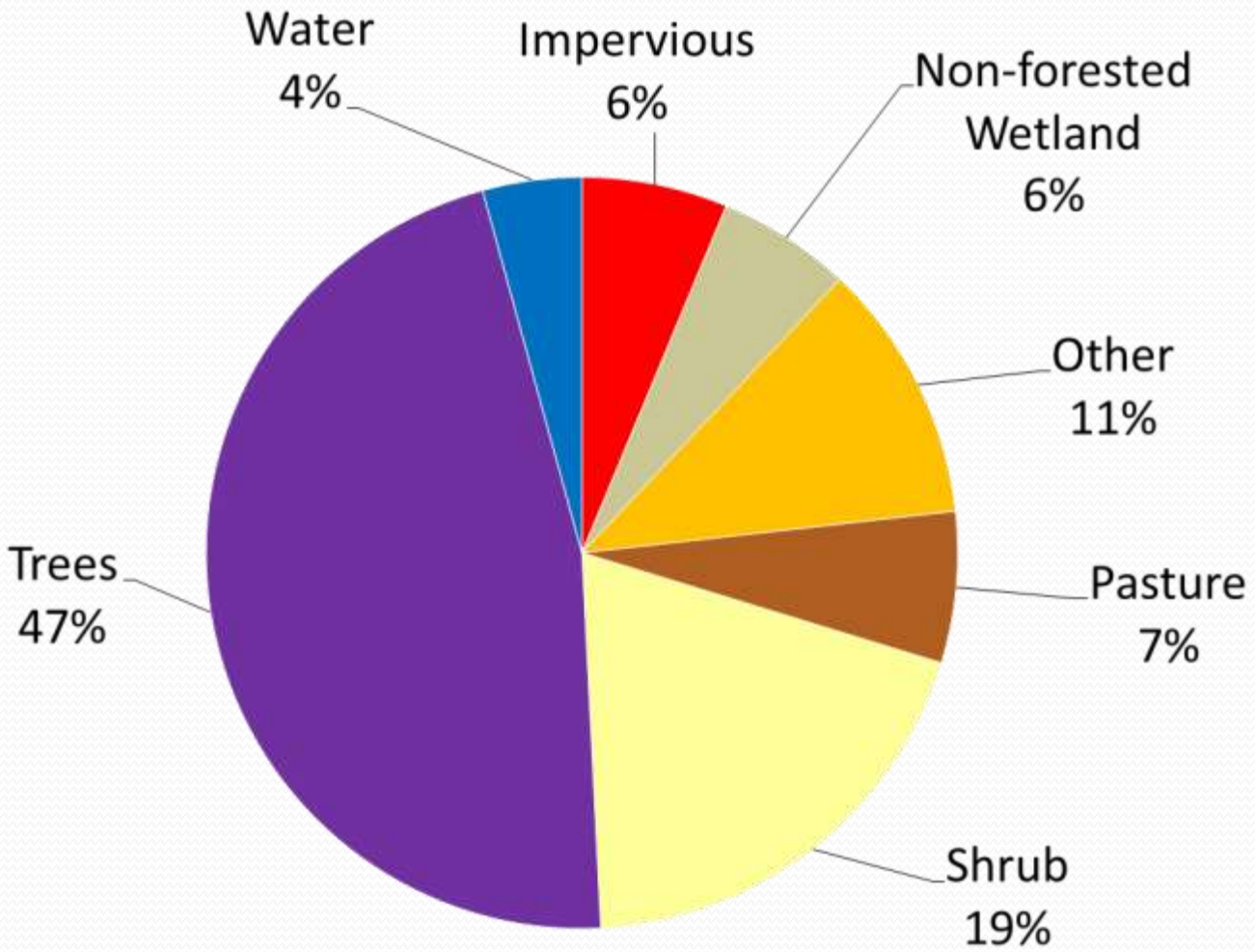
Slice and dice



The 400-ft wide corridor can be clipped – to estimate areas relevant to regulations, for example.

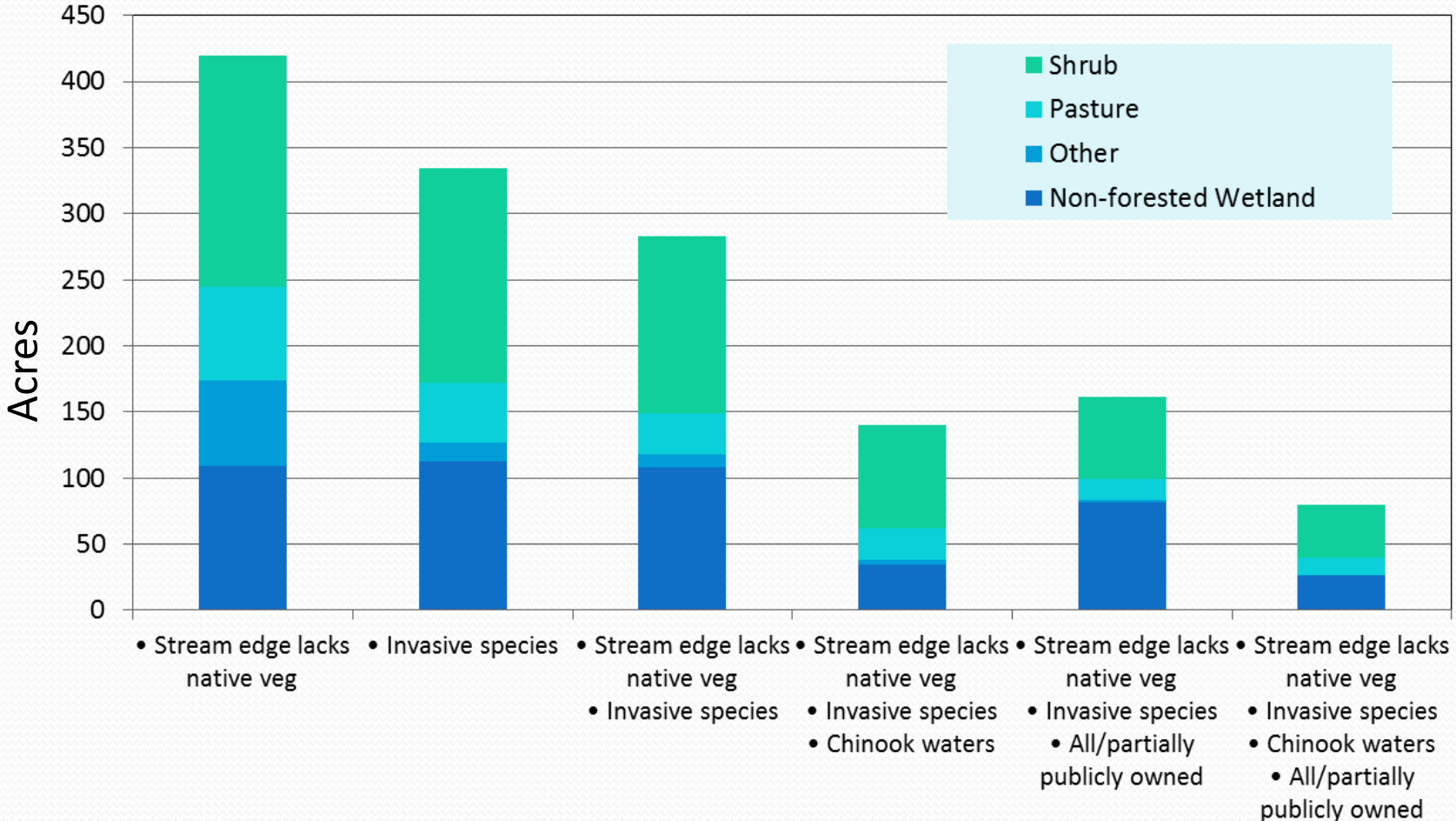
	200 ft		165 ft		150 ft	
Land cover class	acres	percent	acres	percent	acres	percent
Impervious	151.1	6.9%	114.2	6.3%	98.6	5.9%
Non-forested Wetland	116.2	5.3%	104.6	5.8%	99.0	6.0%
Other	270.6	12.4%	203.5	11.2%	176.7	10.7%
Pasture	153.1	7.0%	118.4	6.5%	103.9	6.3%
Possible Beaver Dam	0.6	0.03%	0.6	0.03%	0.6	0.04%
Shrub	398.2	18.2%	353.9	19.5%	333.8	20.1%
Trees	1016.3	46.4%	846.3	46.5%	771.2	46.5%
Water	84.2	3.8%	77.5	4.3%	74.1	4.5%
Total	2190.3		1818.9		1658.1	

Land cover in 165-ft buffer



Attributes

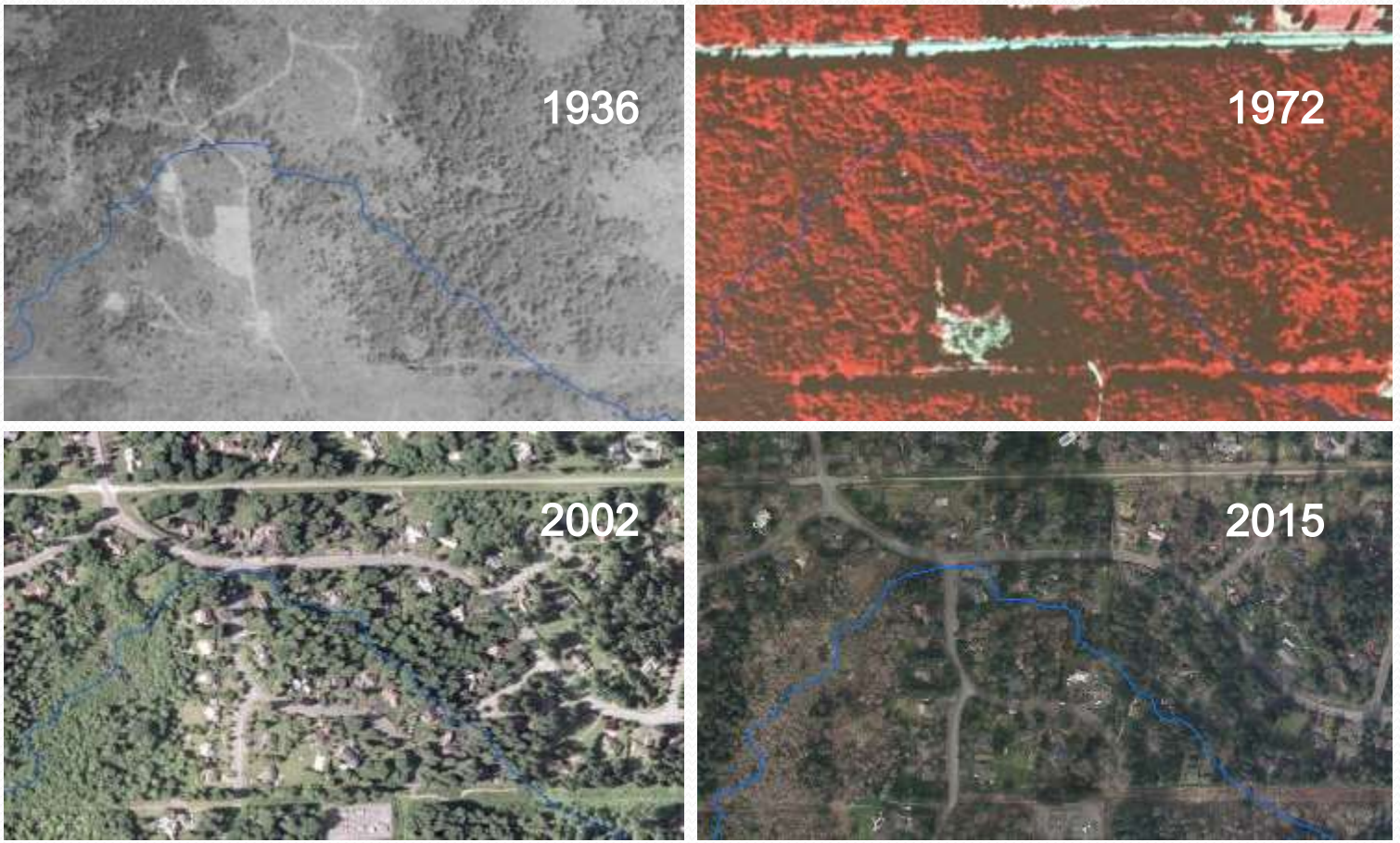
- Invasive species
- Cleared to edge/no shade
- Publicly owned
- Chinook waters



History of forest change

Missing photos:

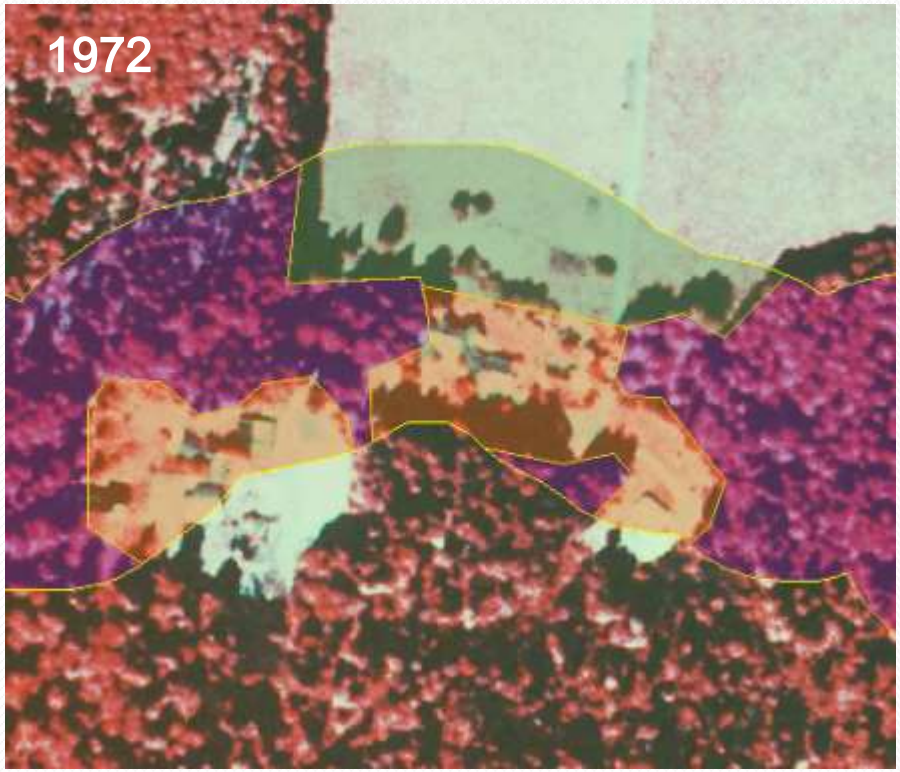
- Pre-settlement mid-1800s old-growth
- Post-logging early 1900s

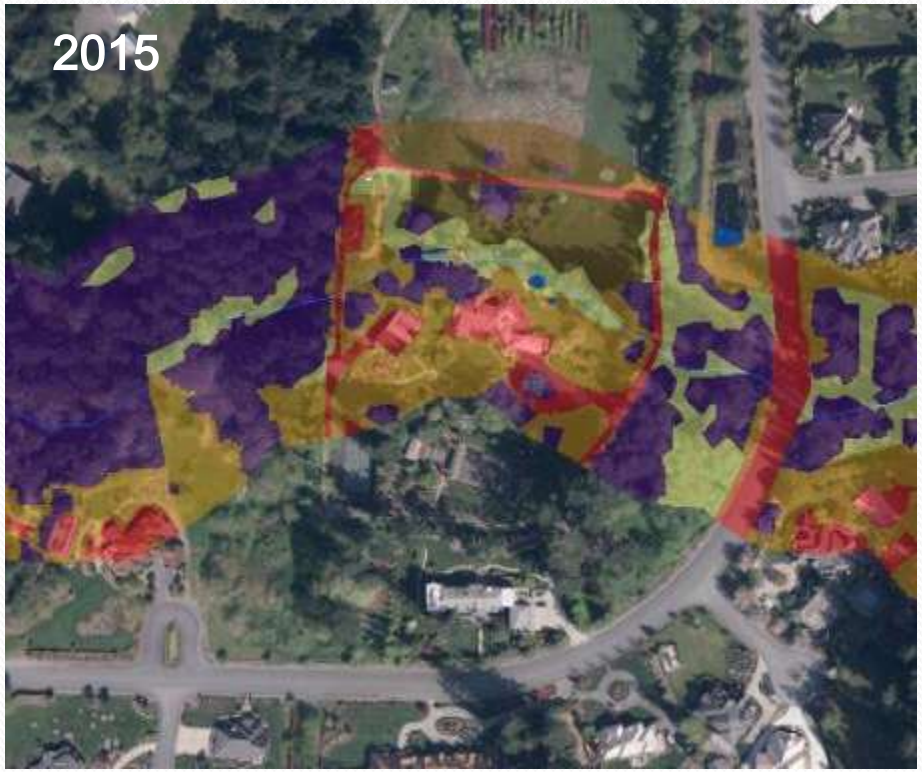


80-year progression of photos at NE 146th Way & 186th Place NE

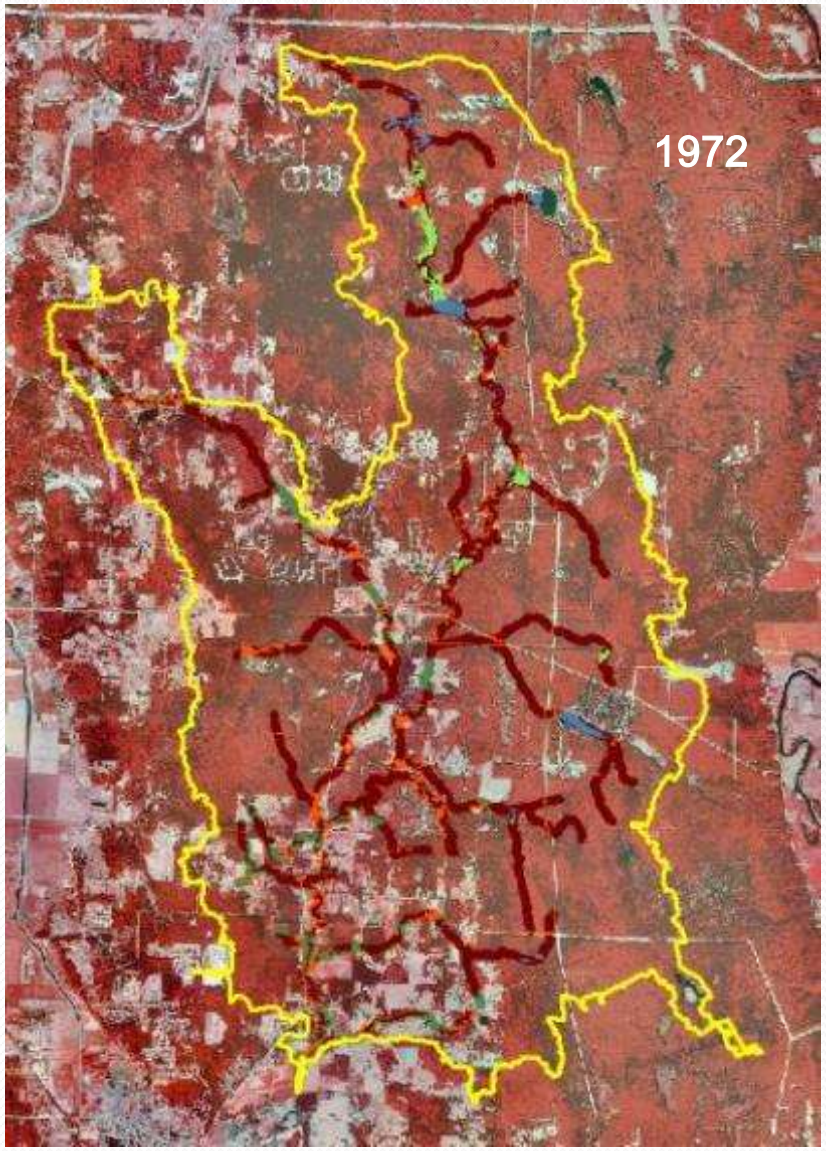
Limited data for change analysis

- 1972 aerial imagery poor resolution= need broad categories of land cover.





1972 gross-level land cover digitization versus fine-scale 2015 .



1972 land cover

400-ft corridor results

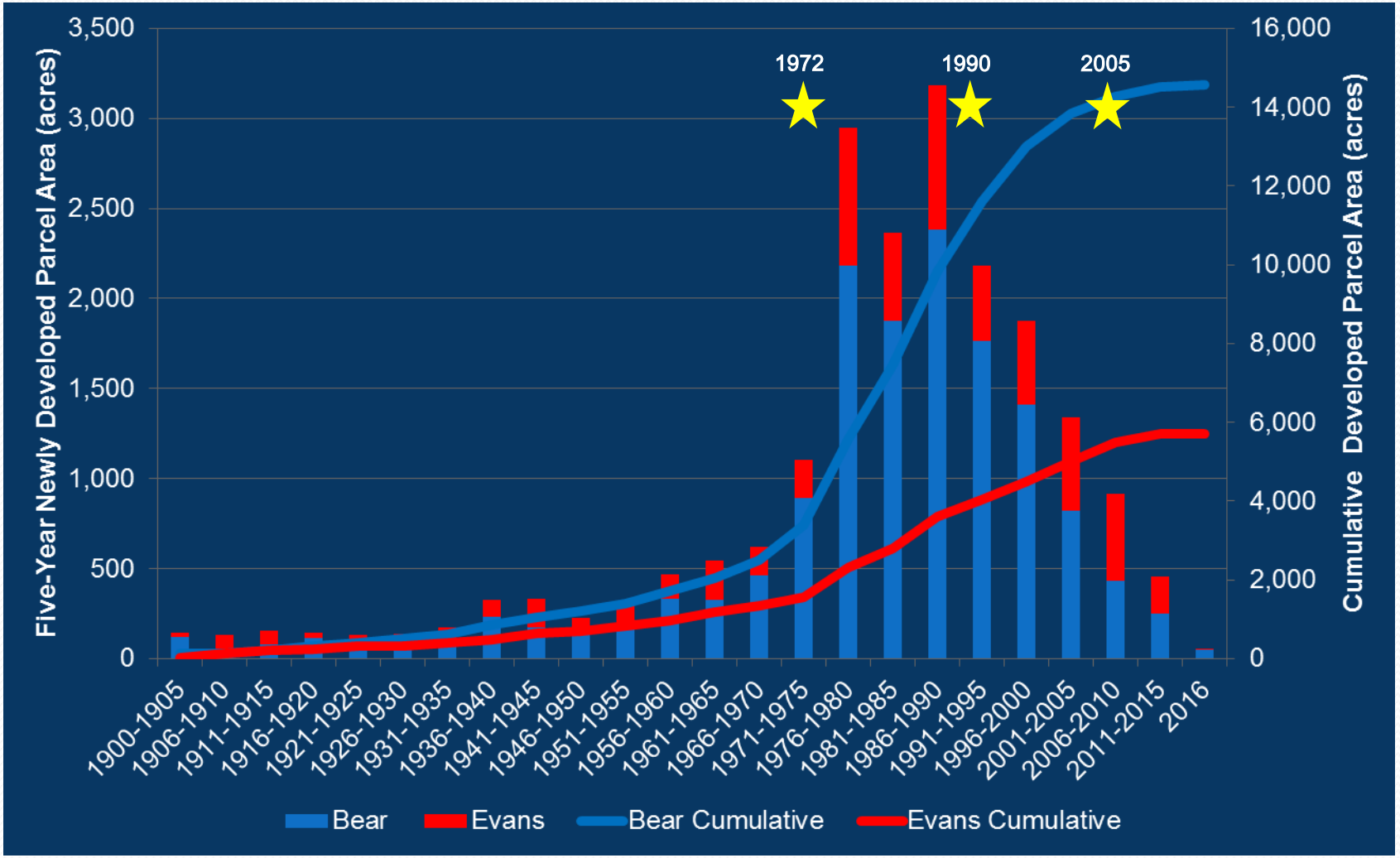
1972 Land cover	Acres	Percent
Disturbed	295.0	13.5%
Forest	1492.7	68.2%
Wet Vegetation	61.6	2.8%
Shrub	7.2	0.3%
Pasture	262.6	12.0%
Water	70.4	3.2%
	2189.5	

Changes over past 43 years

- From a time of reforested conditions to now:
  - Forest and native shrub combined decreased from 69% to 58%
  - Disturbed area (not including pasture) increased from 14% to 27%

Land Cover in 400 ft corridor	1972	2015
Disturbed areas (Impervious + Non-native Shrub + Other)	13.5%	26.7%
Native Vegetation (Trees/Forest + Native Shrub)	68.5%	57.2%
Forest/Tree	68.2%	46.4%
Pasture	12%	7%

Urbanization & riparian land cover



Riparian Assessment Summary

- Riparian areas are important because of their role in the watershed's hydrology & ecology
- Currently a 165-ft wetland buffer in the riparian study area includes:
  - 47% trees (of varying age, species, function)
  - 6% impervious surface
  - 19% shrub
- Change analysis shows ~22% less riparian trees than in 1972, when development was beginning to climb

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Webinar Summary and Next Steps

Jeff Burkey

Bear Creek Technical Webinar

December 12, 2016

Department of Natural Resources and Parks
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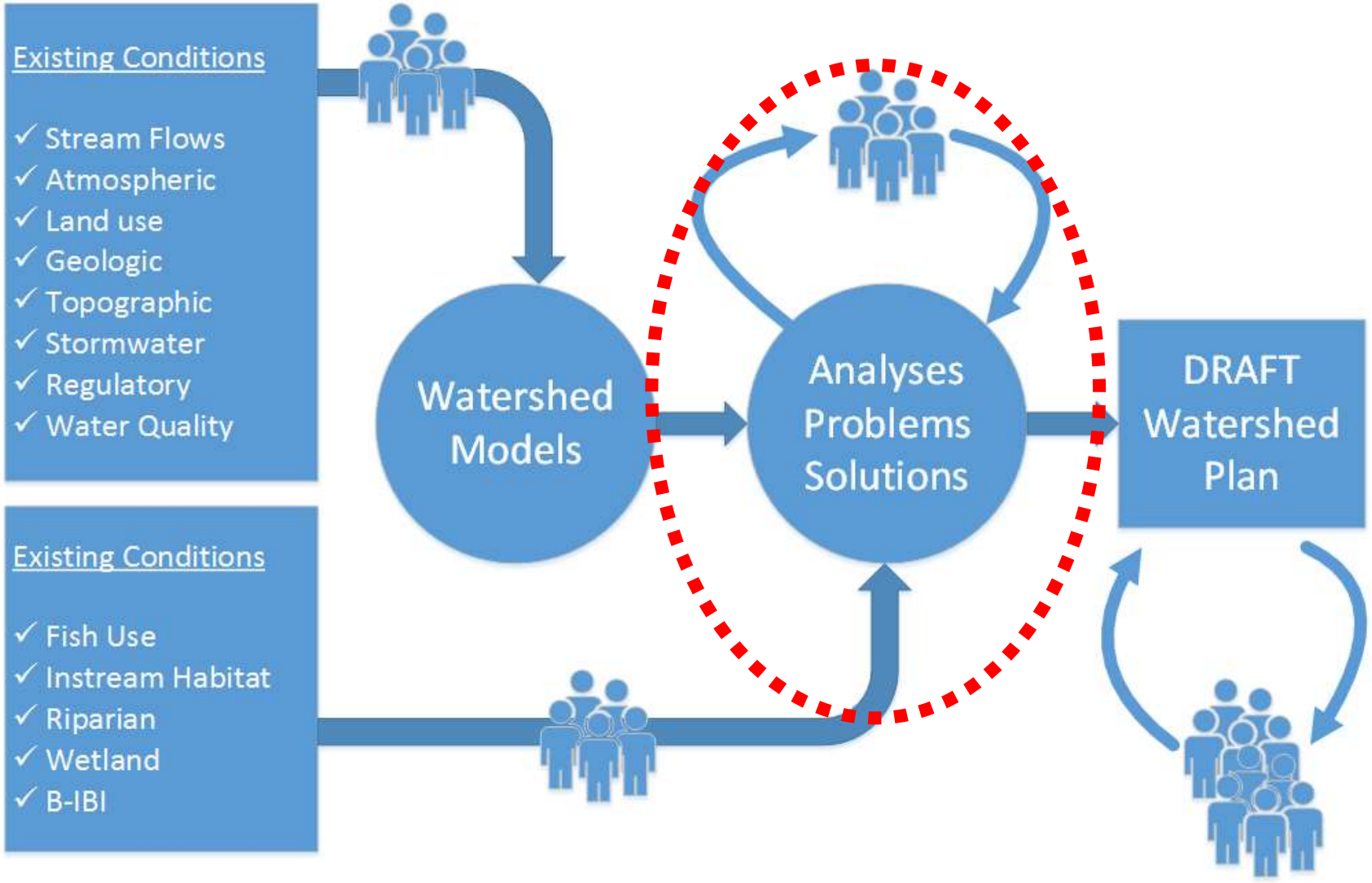
Summary and Next Steps



Partners

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- City of Woodinville
- WA Dept. of Transportation

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